DEPARTMENT OF RAILWAYS : NEW SOUTH WALES
MECHANICAL BRANCH

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46 CLASS ELECTRIC LOCOMOTIVES

GENERAL WORKING INSTRUCTIONS FOR FIREMEN – OBSERVERS

BY AUTHORITY

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INTRODUCTORY.

This manual, intended primarily for firemen-observers already employed on Electric locomotives, is also valuable to all employees in this classification as an introduction to a comparatively new locomotive type, the use of which will undoubtedly extend to other lines, in the near future.

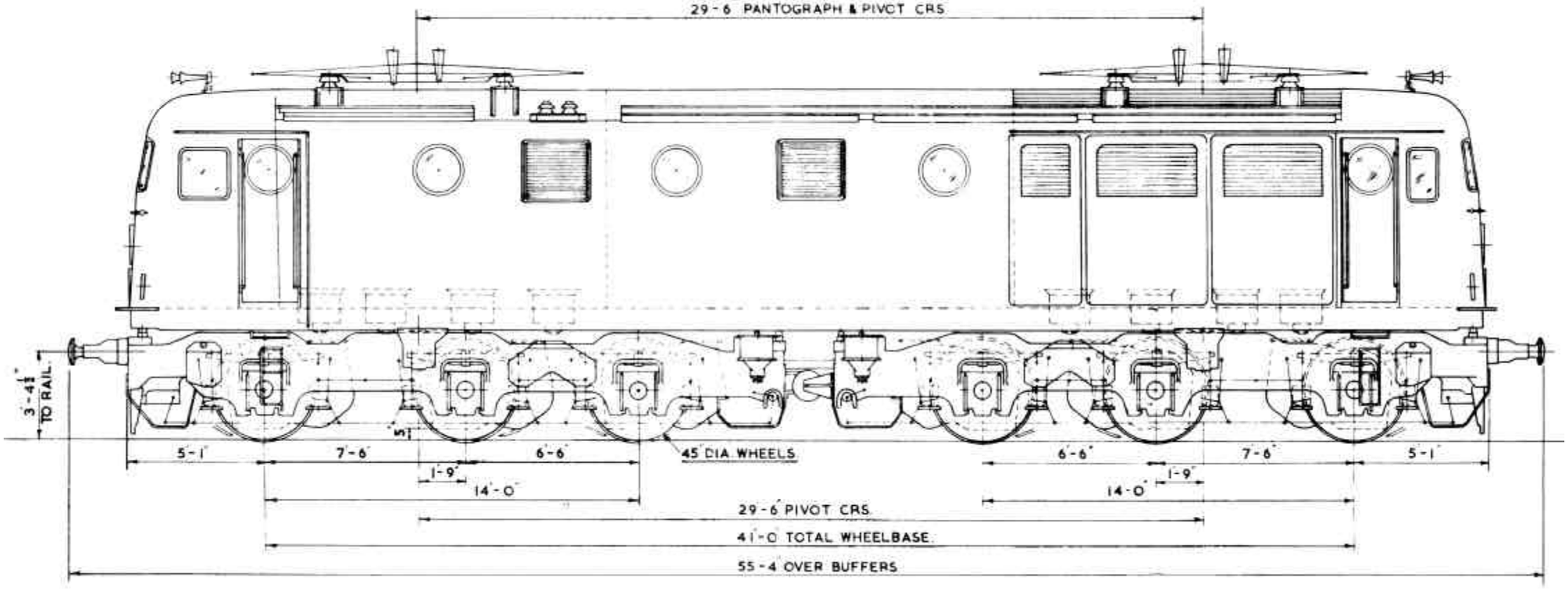
There is also the aspect that normal promotion and progression in the service will naturally bring the present fireman-observers to a point in their career where they must quality for the more exacting duties of driving this locomotive type.

In this latter regard it should be appreciated that the present group of firemen observers is now being afforded an opportunity which was denied the present group of electric locomotive drivers in so fas as, that the fireman-observer may gradually approach the subject and at the same time improve his grounding in the company of his driver.

This manual commences with an explanation of the duties and responsibilities of all firemen-observers currently employed.

Following this information a limited amount of fundamental knowledge of electricity is provided, and then in progression, are descriptive items of how electric current is controlled, routed and generally employed.

There is additionally available to all members of the Railways Institute a short informative course on 46 class locomotives, which deals in more detail with fundamentals, and the various circuits employed, together with the component machines and their functions.


29-6 PANTOGRAPH & PIVOT CRS
3-4½" TO RAIL
5'-1"
7'-6"
1'-9"
6'-6"
14'-0"
45" DIA WHEELS
6'-6"
7'-6"
5'-1"
1'-9"
14'-0"
29-6 PIVOT CRS
41'-0 TOTAL WHEELBASE
55-4 OVER BUFFERS

INDEX.

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ITEM 1.

LIST OF PREPARATION, STABLING, ROAD AND EMERGENCY DUTIES TO BE PERFORMED BY FIREMEN WHEN EMPLOYED AS OBSERVERS ON '46' CLASS ELECTRIC LOCOMOTIVES.

PREPARATION DUTIES.

1. Unlock 4 doors, inspect kit and fire extinguishers and report to driver.

2. Test all marker and head lights each end and report to driver.

3. Tidy cabs, light hand lamps.

4. Stand by machinery compartment for pantograph raising.

5. Stand by driver in No. 1 Cab and test whistle and window wipers and observe pantograph reaction for driver.

6. Transfer control and brake valve handles to No. 2 end, set and apply independent brake, place other handles on desk.

7. Test wipers and horns and lift hand brakes No. 2 end, and observe pantograph reaction.

8. Set up head and tall marker and/or discs.

9. Pilot locomotive as required to Traffic points.

STABLING DUTIES.

1. Apply hand brakes each end and extinguish hand lamps.

2. Lock three (3) cab doors.

3. Charge storage reservoir and close inlet and outlet P. and C. reservoir isolating cocks.

ROAD DUTIES.

1. Share with the driver the responsibility for hand and all fixed signals, including right-away on driver's side and watching departure of train from platform.

2. To assist driver in changing ends by operating marker lights and/or discs at each end.

3. Operating hand brakes as required.

4. Attending to the correct coupling and uncoupling of the locomotive.

5. Operating of the locomotive in confined areas.

6. Attend any other duties as directed by the driver.

7. Regular inspections from each side of cab of the train details with particular attention to risk of hot axle boxes and dragging brakes.

8. 60" interval inspections of battery charging ammeter.

9. 30" interval inspections of auxiliary machines, etc.

FIREMEN'S DUTIES ON 46 CLASS ELECTRIC LOCOMOTIVES.

ITEM ONE.

The fireman of the 46 class electric locomotive being relieved of the activities of generating steam and associated duties is therefore in a position to give considerable practical assistance, not only in the normal course of train working, but to have the knowledge which will enable him to perform certain duties in emergencies.

PREPARATION.

The preparation of any locomotive is best achieved by following the same routine at all times. Any omission in the preparation then becomes obvious, therefore at all times commence the preparation in the No. 2 cab. The reason being the availability of the battery switch for illumination of the locomotive during darkness. No. 2 cab is always indicated by the high numbers on the axle boxes.

After entering No. 2 cab close the battery switch, check that the hand brake is on, check that the hand lamp is filled, and light if necessary, check that detonators and red flags are available, check that the pressure in the fire extinguisher is 100 p.s.i. and report any deficiency to the driver, switch on all

head and marker lights and observe their efficiency from the ground, being sure to again switch off unrequired lights to save battery drain.

In the corridor between No. 2 cab and the machinery compartment observe the presence of three multiple unit jumper couplings. They should be branded A, B and C. These couplings convey the low tension current from one locomotive to another in multiple working. Also in these corridors are:

Two small air hoses which connect the independent brake pipes of two or more locomotives.

One brake pipe end air hose, one main Reservoir pipe and air hose.

One sealed tool box. (If this seal is damaged or missing, report to driver).

In No. 1 cab make similar tests and inspect as in No. 2 cab.

Now remain in attendance to the driver so that in the machinery compartment, assistance may be given him in pantograph raising (initial) and in each cab, pantograph reaction to the driver's tests. While thus occupying each cab test the whistle valves and wind-screen wipers.

While the driver is carrying out ground level inspections, attend to correct targetting of the locomotive and stand by for hand brake adjustments and piloting of the locomotive as required.

DRIVERS, SPARE, AND EMERGENCY EQUIPMENT.

The following equipment shall be carried in each 46 class electric locomotive:-

DRIVERS EQUIPMENT.

2 Hand lamps. One in each driver's cabin.
1 Tail disc. In No. 1 cabin.
2 cases of 12 Detonators. One in each cabin.
2 Red flags (in flag cases). One in each cabin.

FOR COUPLING TO ANOTHER LOCOMOTIVE.

2 1/2" hose couplings. In No.2 End Corridor.
3 Jumper couplings. In No.2 End Corridor.

TOOLS.

1 Spanner, hose M.R. & T.L.)	(T.L.= B.P.)
" " Bogie M.R.)	
" " " B.Cyl.)	
" " " Sand)	In sealed box in
1 Pin punch 3/8")	No. 1 end corridor.
1 Chisel)	
1 Hammer)	
1 Inspection light and lead)	

SPARE & EMERGENCY EQUIPMENT.

1 Air hose M.R. 3/4")	
1 " " T.L. 1")	
1 " " B.Cyl. 1")	
1 " " Sand 1/2")	In open box in
1 Rope, 40 ft.)	No.1 end
1 Light globe, headlight 250W.)	corridor.
2 " " interior 60W.)	
2 " " marker 40W.)	
2 " " pilot 15W.)	
2 Fuses, Main Aux. H.T. 150A.	In rack in No.1 H.T. Compt.
2 " Gen. H.T. 50A.	In rack in No.1 H.T. Compt.
2 " Comp. H.T. 18A.	In rack in No.1 H.T. Compt.
1 Fuse Spanner.	
2 " L.T. Gen. & Battery	On bottom of L.T. Panel No. 2 end.

Spent H.T. fuses to be placed in box in No. 1 H.T. Compartment.

Spent L.T. fuses to be placed in bottom of No.2 L.T. Panel.

1 Hook stick	In No. 1 End Corridor.
3 Fire Extinguishers	One in each cabin and centre compartment.

STABLING DUTIES.

Between the point of Traffic Release and the stabling site it is the requirement of the fireman-observer to pilot the movement as directed by the driver.

The principal hazards usually are, opposing or converging movements of other locomotives.

Facing points and converging roads also require close inspections.

If at any point a "Road not wired" symbol is located, be sure to stop the locomotive until it is ascertained that the route intended is wired.

This symbol is a yellow coloured reflector board with a pantograph outline (Black) in centre.

If a Siding to be entered has its overhead wiring controlled by a local switch, stop the locomotive and confer with the driver.

Section Insulators at Loco Repair Roads must never be encroached upon, except on authority of the Depot Officer.

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ITEM 1.

STABLING DUTIES.

After arrival at the stabling site, apply both hand brakes, each brake catches only the related bogie.

Close all cab windows, lock three doors.

Extinguish and stow hand lamp.

Inform the driver of all noted defects on the locomotive for entry in the log book.

In the machinery compartment, after the pantographs have been lowered, turn the pantograph control three way cock so that the handle points down. This directs air from the pantograph and control reservoir towards the air Storage Reservoir.

Open the Storage Reservoir air valve for one minute to allow air to store, then close the air valve firmly.

Next close the inlet and outlet cocks to the pantograph and control reservoir to isolate and conserve the compressed air contained therein.

Lock the fourth cab door after egress.

ORDINARY ROAD DUTIES.

The altered speed at which Electric locomotives perform their work causes a much faster starting rate, and train running rate, than any other locomotive type operated and because of these factors the attention of the driver is at times fully taxed.

It is essential that the fireman-observer should fully co-operate with his driver in the matter of fixed and hand signals obedience by calling the indications to the driver as required.

Hand signals from Traffic Branch employees at stations and sidings are to be promptly received, acknowledged and conveyed to the driver.

Careful observance of passenger trains departing from platforms must be made from each side of the cab, as required, by the fireman-observer.

Level crossing risks are to be safeguarded by close scrutiny at all times and further by locomotive whistle where the gates at these are not interlocked with the signals.

The exhibition of a Way and Works Branch yellow flag, red flag or Warning Board, or whistle sign, and the explosion of detonators on the track also calls for an immediate sounding of the whistle and extra vigilance.

Firemen-observers should always consult the Weekly Speed Notice before a journey and will thus be able to anticipate Way and Works Branch requirements and also regulate their routine inspections to suit. At signal stops where the Signal Telephone is to be used, drivers switch off the Supply Motor Generator to reduce noise during conversation; on return to the cab the fireman-observer should note that the Supply Motor Generator is again switched on.

En route, the fireman-observer is required to regularly inspect the cars and wagons comprising the train from both sides of the cab.

Due to the powerful locomotive employed, brake drag or even a derailed vehicle would not be detected by speed drop nearly so quickly as with other locomotive types.

Under certain circumstances also hot axle boxes are more likely to develop due to the overall higher train speed rates.

Hot axle boxes may cause broken axles. Broken axles always cause derailment, serious damage to wagons and consignments for which your employer is responsible.

With broken axle derailments there is always a strong tendency to fouling the opposite track on double lines.

In summary therefore watch the train for blue (oil) smoke.

When in doubt consult the driver.

CHANGING ENDS OF THE LOCOMOTIVE IN TRAIN WORKING.

Where a reversal of locomotive movement is required, at any turn around point in train working or light engine movements, it is required that the crew should transfer the controls to the altered leading end of the locomotive.

The Driver is required to isolate the controls at the end being vacated and set up control at the opposite end.

The fireman-observer is required to close up the cab openings at the end being vacated and in the case of further train working or light engine running attend to the necessary alterations to front end and rear end targetting of the locomotive.

COUPLING AND UNCOUPLING OF THE LOCOMOTIVE.

The driver is always responsible for the manner in which a locomotive is coupled, or uncoupled, from any train.

The fireman-observer, when required to attend to these details should observe the following procedure:-

(a) Select the side to work on, to provide for being in the best range of vision of the driver.

(b) Keep clear of adjacent running lines.

(c) If necessary, stop the locomotive short of the train until auto coupler jaws, transition chains and end air hoses are correctly positioned.

(d) Coupling auto coupler to auto coupler, observe that both coupler locks drop to the locking position, and insert safety catches where provided on locomotives.

(e) Coupling the auto coupler transition chain to a drawhook, ensure that the auto coupler jaw is fully opened.

Where regulations require it, threadle the transition chain with a covering chain.

(f) On all occasions, most particularly where the leading vehicle has a diaphragm buffer, stand outside the buffers until contact is made and motion has ceased.

In uncoupling either from an auto coupler or a drawhook:

(a) Close both end air taps; separate the end air hoses; discharge air from the train and stand outside the buffers to hand-signal the ease up requirement for opening auto jaws or lifting the transition chain.

(b) Hand-signal the locomotive away from the train before targetting train and locomotive and hooking up the locomotive air hose.

MULTIPLE UNIT WORKING.

Assembling or dividing two locomotives.

It is the duty of both firemen-observers to carry out these duties together, where each locomotive is manned. It is the duty of the driver of the rear locomotive to supervise these activities.

Care should be taken to ensure that A.B. & C. control jumpers and Nos. 3 and 4 Westinghouse control jumpers are always stowed after use on the locomotive which provided them.

COUPLING TWO LOCOMOTIVES FOR MULTIPLE UNIT WORKING.

(a) Prepare auto coupler jaws, Brake pipe and main reservoir end air hoses.

(b) After coupling up, test the auto coupler locks and insert the Safety Catches.

(c) Couple Brake pipe air hoses and main reservoir air hoses and open the four associated air cocks.

(d) Couple the No. 3 and 4 Westinghouse Control air hoses and open the associated four air cocks.

(e) Insert and force fully home the B.C. & A. control jumpers in the corresponding jumper sockets and in the order of B.C. and A.

(f) Extinguish marker lights between locomotives.

UNCOUPLING TWO LOCOMOTIVES.

(a) Remove Control jumpers A.C.B. in that order.

(b) Remove Westinghouse Control Nos. 3 and 4 jumpers, close cocks.

(c) Stow all control jumpers in the correct locomotive.

(d) Close Brake pipe and main reservoir end air hose cocks and divide hoses.

(e) Uncouple auto couplers, signal the front locomotive clear, hook up end air hoses and adjust marker lights.

INSPECTIONS.

At regular intervals of about 60", unless some abnormal condition exists, it is a requirement of the fireman-observer to select sites where fixed signals are not located to inspect the Machinery Compartment details and the low tension cabinet (No. 2 cab).

In the machinery compartment there are four Auxiliary machines which are driven by four separate high tension motors.

Overheating signs of any of these should be carefully checked and reported on.

On each compressor there is a lubrication oil vapour discharge vent.

It is a normal function that a minor amount of vapour should be discharged.

Elsewhere any smoke should be treated as a defect and reported on.

In two separate cabinets in this compartment there are housed a total of eight thermal type circuit breakers which control current flow to the Resistance Fan motors.

Unless a continuous yellow light shines in the cab it may be assumed that the circuit breakers have not tripped.

The Pantograph and Control air pressure gauge should show at least 70. P.S.I.

ITEM 1.

EMERGENCY DUTIES.

FIRES ON ELECTRIC LOCOMOTIVES.

Three (3) fire extinguishers, each with a minimum pressure of 100 P.S.I. are carried on all 46 class locomotives, one in each cab and one in the machinery compartment.

It is the duty of the fireman-observer to use this equipment as required.

The extinguishers are portable and should be carried to the fire site, upright.

Point the nozzle of the flexible hose to the base of the fire and operate the wheel valve.

Each use must be recorded in the locomotive log book.

LOCOMOTIVE ROOF FIRES.

To gain sufficient height to deal with these, do not rise above head level with the locomotive roof, and both pantographs should be lowered whilst the fire is being dealt with.

Before any fire is dealt with, current must be cut off from the circuit on fire.

To disconnect high tension current from the locomotive, the both pantographs must be lowered.

To disconnect low tension current within the locomotive the Supply Motor Generator must be switched off and the Battery Switch opened.

Remember that in each of these cases the Westinghouse air Brake Compressors will not run and security of the train must be considered accordingly.

SECURITY OF TRAINS ON HEAVY GRADIENTS WHERE THE WESTING-HOUSE BRAKE AIR COMPRESSORS HAVE FAILED.

On a direction from the driver to carry out this duty, the fireman is to immediately proceed along the Cess side of the train, applying the hand brakes on every vehicle, or to that point where he meets the guard and has his assurance that the remainder of the brakes have been applied.

In addition the requirement is to sprag the six (6) vehicles at that end of the train indicated by the falling gradient.

Any message from the driver to the guard should be accurately given and the fireman-observer is then to return promptly to the driver unless otherwise directed.

Where it is a further requirement of the fireman-observer to proceed to a Block Station or Signal Telephone to obtain assistance or relief locomotive, he should ensure that he carries the correct safe working form, accurately filled in and addressed, a red flag, lighted handlamp and the canister of detonators.

APPLICATION OF THE INDEPENDENT WESTINGHOUSE AIR BRAKE AND THE AUTOMATIC AIR BRAKE ON 46 CLASS LOCOMOTIVES.

During preparation duties and to meet the emergency of a driver being incapacitated on the main line the fireman-observer is required to apply the Independent brake.

This Brake valve has five operating positions viz. (from left to right movement of the handle):

(1) Fast release.
(2) Running position (and slow release).
(3) Lap (or holding).
(4) Slow application.
(5) Fast application.

On any occasion where the fireman-observer uses this brake it should be placed and left in either No.4 or No.5 positions to ensure continuous holding of the brake.

The Red pointer of the duplex air gauge registers the air pressure being applied. This is limited to 45 P.S.I.

On the main line, if the driver should become incapacitated, the fireman-observer is required to bring the train to a stand and hold it thus.

Following this action he is required further to bring the guard forward to assist him to handle the situation.

The fireman-observer should avoid leaving the locomotive for this purpose.

The whistle or hand signal or use of any messenger available should be availed of to bring the guard forward.

To bring the train to a stand the throttle (accelerating handle) should be moved to the 'off' position and the automatic brake valve moved to service application position to reduce the brake pipe pressure by 25 P.S.I.

The brake valve handle should then be placed at the "lap" position to hold all brakes applied.

The brake pipe pressure is shown on the black pointer on each of the two duplex air gauges.

The automatic brake valve handle has five (5) positions which are: (from left to right).

(1) Full Release.
(2) Release and Running position.
(3) Lap (or holding position).
(4) Service application position.
(5) Emergency application position.

CUTTING OFF CURRENT FEED TO THE TRACTION MOTORS.

This emergency action requirement of the fireman-observer is also necessary, just as is the closing of the throttle of the steam locomotive.

The accelerating handle (throttle) is the middle lever of the three positioned at the driver's station.

It has twenty (20) notches of graduation between the fully closed and the fully open position.

It is opened (to permit current feed to the traction motors) by moving it, one notch at a time, towards the driver's station.

It may be closed (thus cutting off current feed to the traction motors) by moving it fully forward (away from the driver's station).

Care must he taken not to hold in the transition plunger at the end of the accelerating handle, as this purposely prevents the fully closing of throttle.

The two gauges marked Ammeters should be observed and each should indicate zero if the throttle has been correctly closed.

If due to any cause, the accelerating handle (throttle) cannot be closed, the current feed to the traction motors may be effectively cut off by simply turning the control key to the "off" position.

Immediately the control key is turned to "off" the line switches open and disconnect current feed to the traction motors and the red lamp shines to indicate this event.

The control key should then be turned to "on" again and left in that position.

This action will not permit current to again be fed to the traction motors, but will restore current feed to the air compressor motors, thus ensuring Westinghouse Brake control of the train.

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ITEM 2.

In cases where it is necessary to prepare or stable two '46' class Electric locomotives working in multiple the following allowances are to apply:

PREPARATION.

Driver ..... 50"	(40" for preparation of units,
Fireman ..... 50"	20" for each locomotive. 10" to obtain jumper coupling assemble the two units and carry out necessary tests).

STABLING.

Driver ..... 20"	(10" uncouple units and stow
Fireman ..... 20"	jumper coupling. 10" to stable locomotives, 5" for each unit.

Any approved walking times and signing on or off duty allowances are to be added to the above.

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ITEM 3.

STANDARD EXAMINATION QUESTIONS.

Practical conversion course for locomotive firemen, Steam or Diesel-Electric locomotives, to Electric locomotives, is applied by one shift of instruction on a stationary 46 class locomotive. Hereunder is the standard examination.

'46' CLASS LOCOMOTIVE FIREMANS' EXAMINATION

1. What is the purpose of the Storage Reservoir?

2. What is the alternative supply of air if the storage reservoir is empty?

3. What is the proceedure to fill the storage reservoir?

4. How is air obtained from the storage reservoir for pantograph raising?

5. What is the normal position for the three way pantograph control cocks?

6. How many fire extinguishers are there and what is the regulation pressure in each?

7. What is the correct method of operating the fire extinguishers?

8. What are the fireman's duties regarding pantograph reaction?

9. Where is the high tension current located on the locomotive?

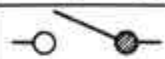
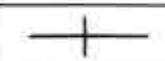
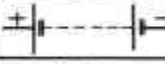
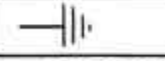
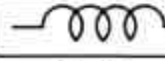
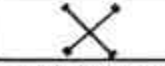
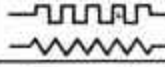
10. In the event of a compressor failure and/or an overhead supply failure on a heavy falling grade what are the regulations for securing the train?

11. What is the holding position for the independent brake?

12. What is the routine associated with a service application of the automatic brake?

13. How may the power be cut off to the traction motors and still be retained to the compressors etc?

In order to assist the student in tracing electric current paths the following symbols are presented together with appropriate explanation.

SYMBOL	ELECTRICAL DEVICES.
+ or +ve	Positive
− or −ve	Negative
	Air Break Switch (open)
	Fuse
	Circuit Breaker (open)
	Conductor or wire
	Conductors crossing and not connected.
	Conductors crossing and connected (Junction)
	Voltmeter
	Ammeter
	Generator
	Motor
	Battery
	Unit switch
	Earth connection or rail return to sub-station
	Field winding or electro-magnet coil.
	Reverser
	Resistance unit or rheostat.
	Ammeter shunt. (Sometimes used as ammeter symbol.)

14. Where are the Rheostats fan motors circuit breakers located?

15. How many of these circuit breakers are there and how may they be reset?

16. Where is the location of the low tension panels of miniature circuit breakers and which are the most important of these?

17. What is the correct order for M.U. Jumper Couplings and air hoses when coupling to another 46 class locomotive?

18. What are the fireman's duties regarding the grade control valves at Valley Heights on the Up journey?

19. State the fireman (a) preparation duties (b) stabling duties (c) road duties. (Including coupling and uncoupling of locomotives in Multiple Unit working).

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The foregoing examination represents the basic standard requirement.

It is quite reasonably expected of firemen-observers employed on electric locomotives, that due to opportunities now presented, they should progressively improve their knowledge of the locomotive parts and functions and train working. To this end observation of the driver's activities and discussions with him is one very good method.

Locomotive Running Inspectors necessarily have an expert knowledge of all of the associated matter and firemen-observers should never hesitate to take advantage of this source of instruction and information, when present.

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ITEM 4.

ELECTRIC CURRENT. ITS ORIGIN AND USE.

Just as steam is the invisible agent to which pressure is applied in order to drive a steam locomotive so is current the invisible agent to which pressure is applied in order to drive an electric or diesel-electric locomotive.

Electric current is measured in amperes and a gauge termed an ammeter is employed in electric circuits to show just what volume of current is being fed to a circuit.

Before current may flow through a circuit two conditions must always be provided, they are:

(a) A complete circuit or path must be provided from the source of supply, through a resistance and back to the source of supply.

This source of supply takes the form of a Generator or a Storage Battery.

(b) A pressure which is usually called Voltage or Electromotive Force, must be made available to push the current through the circuit.

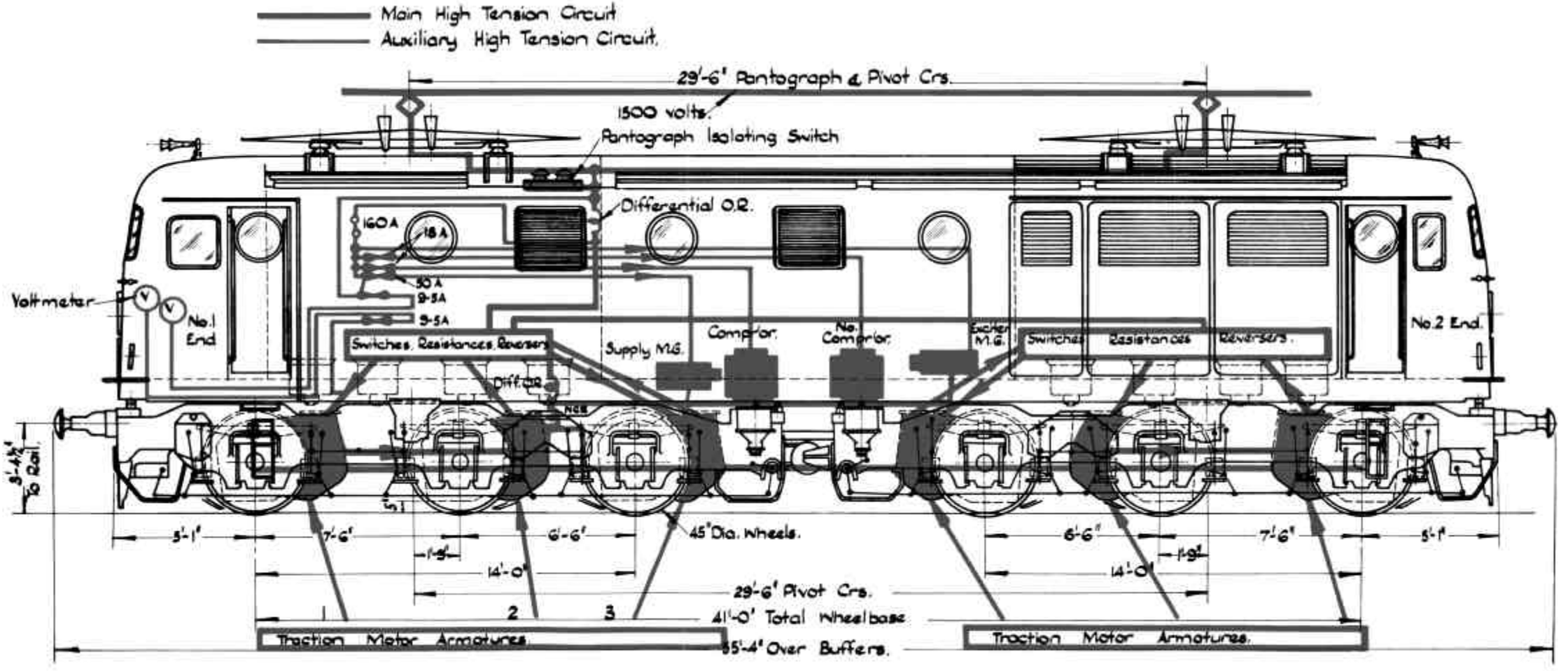
A Voltmeter is a gauge which measures the voltage or pressure which is available to push current through a circuit.

Therefore, the higher the voltage available, the greater is the amount of current which may be pushed through the circuit.

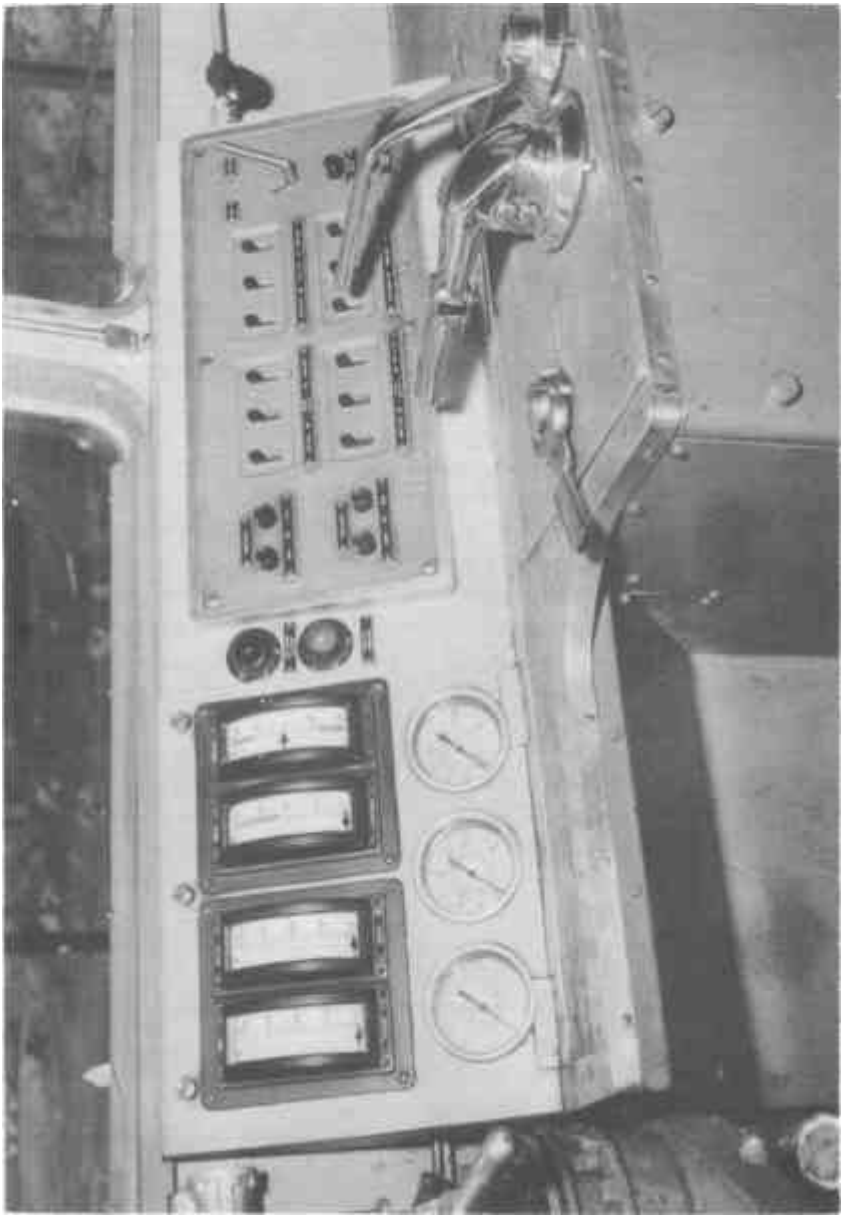
On a Diesel-Electric locomotive the Diesel Engine is used to drive a Generator of suitable size thus providing the voltage or pressure necessary to push current via cables and contactors to the traction motors.

On an Electric locomotive voltage or pressure is obtained from the overhead wiring to push current via cables and contactors to the traction motors.

At the associated power houses, diesel engines, coal fired boilers and sometimes the force of falling water is used to drive Generators of suitable capacity and these prime-movers feed and maintain the voltage or pressure in the overhead wiring.



MAIN AND AUXILIARY HIGH TENSION CIRCUITS.



DRIVER'S CONTROL PANEL.

The voltage or pressure which is maintained in the overhead wiring for the use by Electric locomotives and Electric trains is maintained at about 1,500 volts.

Under certain circumstances this line voltage may vary up or down by two or three hundred volts, but at all times it is regarded as High Voltage or High Tension current and great care is necessary to avoid the risk of human contact with it in that location or any connections to it within or about the locomotive.

Remember well also that most metals and an unbroken jet of water will act as conductors of this current.

The following items are considered to be High Tension equipment:

The pantographs and connections and all roof rigging.

All equipment housed in both Nos. 1 and 2 High Tension compartments.

The voltmeters in each cab.

The motors which drive the four auxiliary machines and the associated cable connections.

The six traction motors and the cable connections.

All of this equipment is reasonably well secured against human contact.

To disconnect High Tension current from any locomotive lower the pantographs and isolate them by closing the respective isolating cocks.

If the pantograph cannot be lowered, use the hooked stick to open both pantograph switches.

It must never be assumed that any pantograph has moved in either direction without visual inspection.

.....

ITEM 5.

CIRCUITS. CIRCUIT BREAKERS, SWITCHES, FUSES.

An electrical circuit may be described as the path through which current is caused to flow, together with the source of supply of current flow, (usually a generator or storage battery), the equipment being operated, the fuses which protect the circuit, and, the switches and circuit breakers which control the current flow.

A closed circuit is a complete circuit where current flows through the items described above.

An open circuit is a potential circuit as described but where due to some break in the total path, current cannot flow.

Since one of the essentials for current to flow is a complete circuit, the opening of a switch or circuit breaker, or the burning out of a fuse, will cause an open circuit.

A switch or circuit breaker may therefore be described as an item employed to provide for the control of current flow.

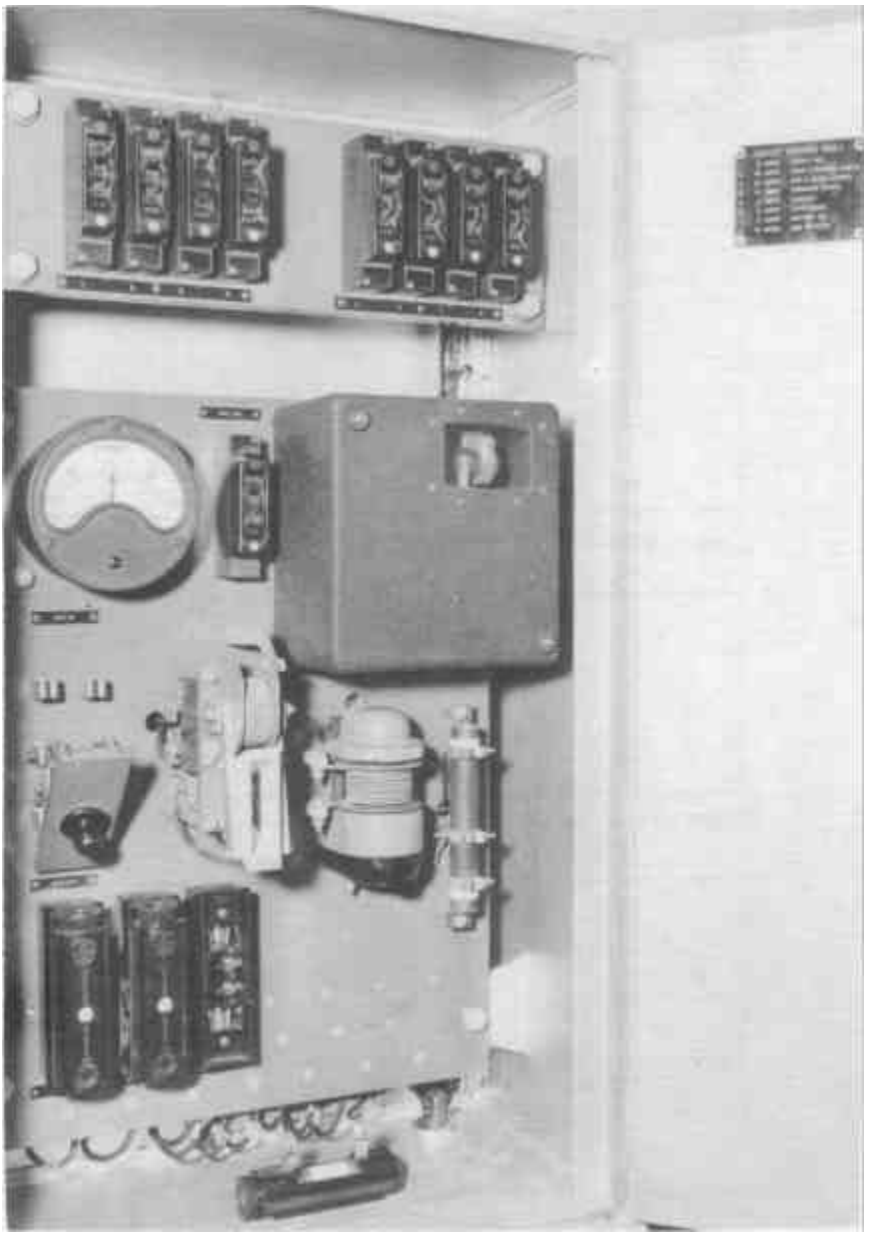
A fuse is a safety device placed in a circuit to protect that circuit from a harmful surge of current.

The action of a fuse is therefore to automatically open the circuit and prevent further current flow, where a harmfully high current surge is present.

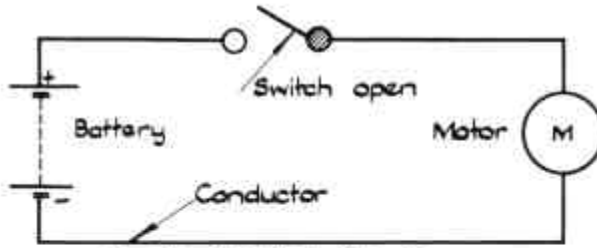
With the cartridge type fuse a strip of conducting wire of some predetermined fusing value is used. Thus, where current surge appears, the fuse wire fuses or burns, thus becoming broken and disconnecting the circuit.

On a 46 class locomotive there are nine cartridge type fuses employed in the various circuits.

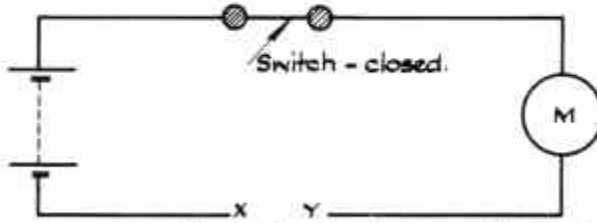
In the auxiliary High Tension circuit there are:
One 160 ampere fuse which protects the auxiliary circuit.
one 50 ampere fuse which protects the supply generator motor.
two 18 ampere fuses which respectively protect the two compressor motors.
two 9.5 ampere fuses which protect the four voltmeters.



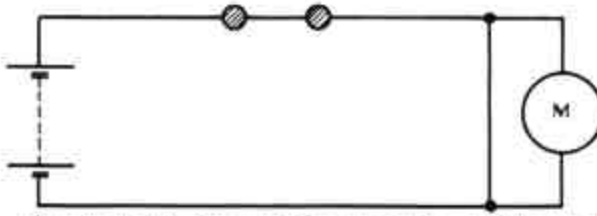
LOW TENSION PANEL : NO. 2 END.



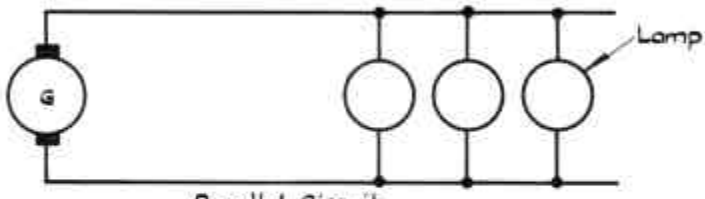
Simple Electrical Circuit.



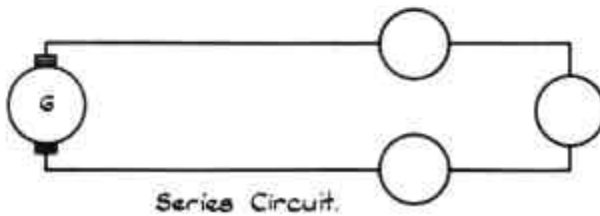
Open circuit. Conductor broken at 'x' and 'y'.



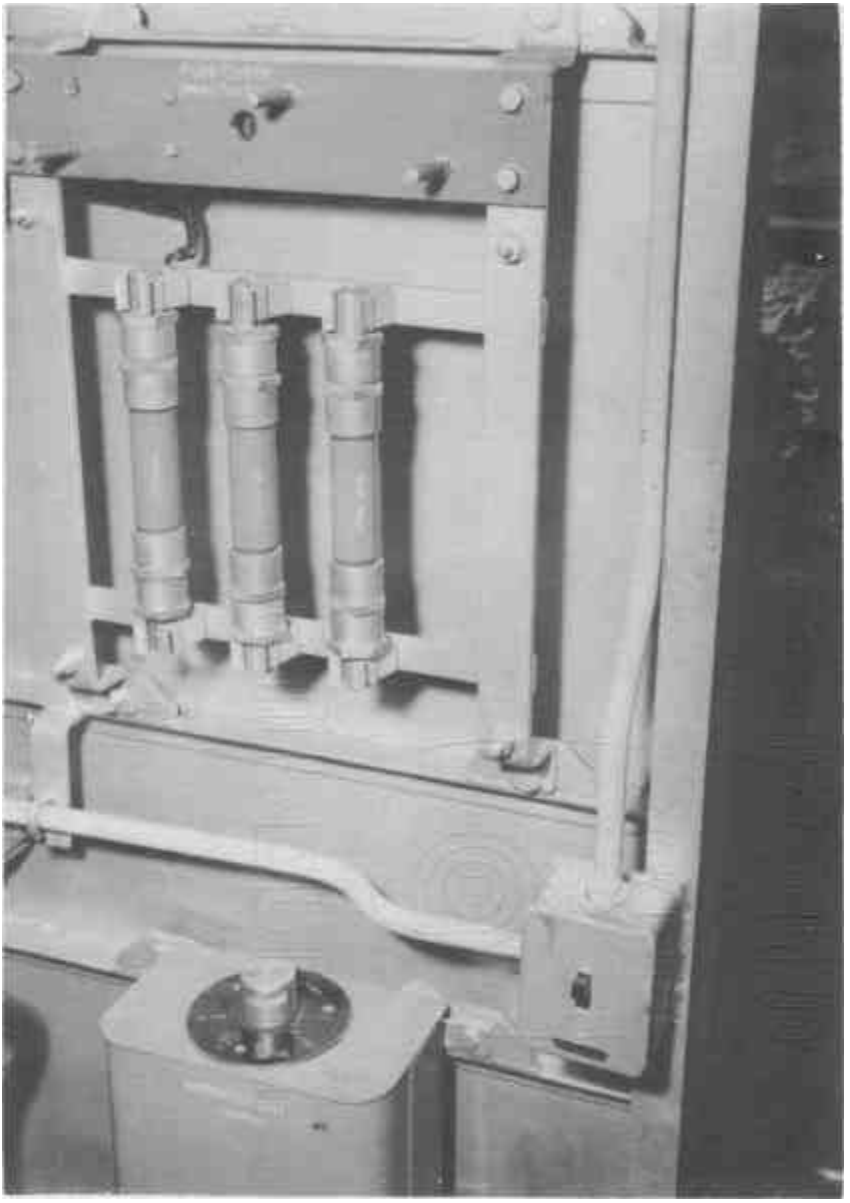
Short circuit. Conductors touching at 'x' and 'y'.



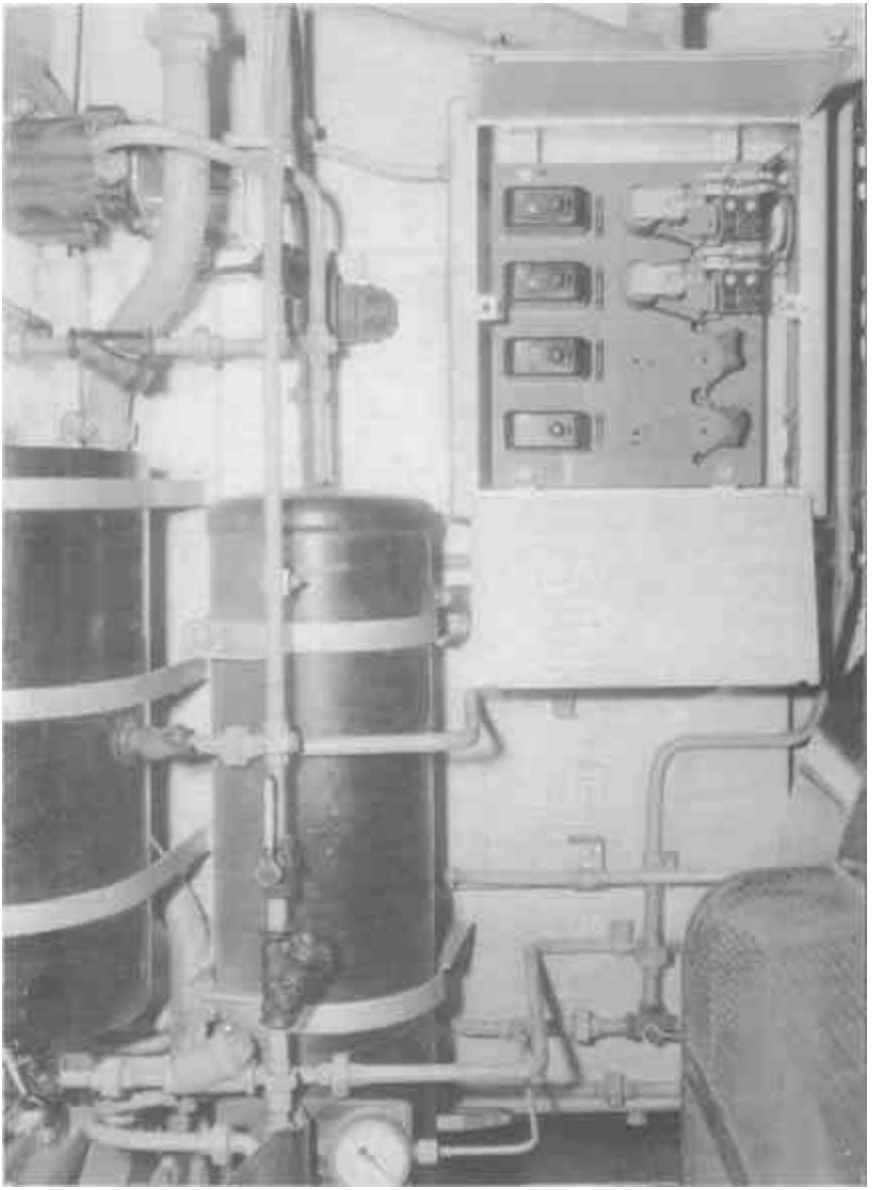
Parallel Circuit.



Series Circuit.



FUSE TEST PANEL, SPARE FUSES AND MOTOR CUT-OUT SWITCH.



RESISTANCE FAN MOTOR MINIATURE CIRCUIT BREAKERS AND FAN TIME DELAY RESERVOIR.

In the low tension circuit there are three fuses, these are:

The 100 ampere Supply Generator fuse which protects the control circuit.
The 100 ampere Battery positive fuse and the 100 ampere Battery negative fuse which protect the batteries.

Before any fuse in any circuit is handled for any reason, including renewal, the corresponding circuit must be isolated by opening the controlling circuit breaker.

The very good reason for this precaution is that whilst a burnt out fuse has automatically disconnected the original circuit, contact with the hand may provide a new and shorter path or circuit through the human body.

There is another protective device employed in low tension circuits termed a thermal circuit breaker. This item is a circuit breaker which has an inbuilt thermal strip which reacts like a fuse in so far as that if a harmful current surge appears the thermal strip relaxes and trips the circuit breaker open, thus opening the circuit.

Unlike the cartridge type fuse, renewal is not necessary. Allow the thermal strip a short time to cool off, then reset the switch.

Never hold a thermal circuit breaker at the "on" position. This would defeat its purpose.

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ITEM 5.

MAGNETIC TYPE SWITCHES AND ELECTRO-PNEUMATIC TYPE CONTACTORS.

These two devices, since they are basically switches, are employed on the 46 class locomotive to connect or disconnect or vary the route of current flow.

As these are employed in the High Tension circuit, it is necessary that they be remotely controlled in the opening and closing actions.

Examples of the magnetic type switches are the two contactors which apply and disconnect the high tension current feed to the two air compressor motors.

Examples of the Electro-pneumatic type contactors are the six line switches and the Starting Resistance contactors.

All of these are necessarily housed in the high tension compartments of the locomotive.

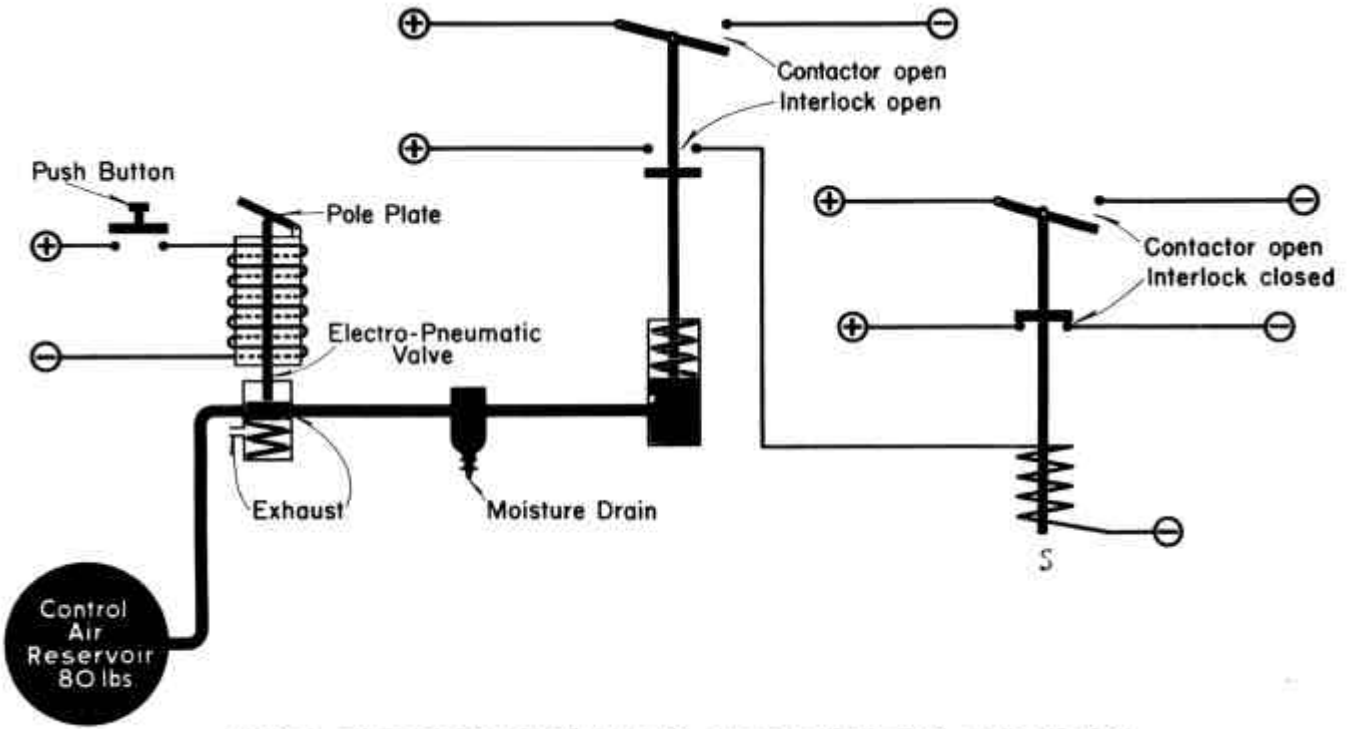
Each of these types relies on the principle of a temporary magnet to close them and hold them closed, and a spring which opens them when the temporary magnetism is destroyed.

The closing of the contactor faces connects the high tension current, and the opening of the faces disconnects the high tension current.

With the magnetic type switch, a Solenoid coil is fixed to one of the arms of the contactor.

Control current (from the supply motor generator or the storage batteries) is used to energise the coil, which now becomes magnetised and thus attracts and holds the second arm of the contactors.

With the electro-pneumatic type contactors, the Solenoid is used as a temporary magnet to control the passage of compressed air (Pantograph and Control Reservoir air) to a small air cylinder.



BASIC ELECTRO-PNEUMATIC AND ELECTRO-MAGNETIC CONTACTORS AND INTERLOCKS

The piston in the cylinder is linked to a moving contactor arm.

The thrust of the air piston forces together and holds the contactor faces, thus permitting current to flow.

When control current is switched off to the Solenoid, the magnetism disappears.

A spring reverses the control air valve, which cuts off control air flow to the air piston and exhausts the air from the air piston.

A spring now forces the air piston back and the contactor faces are parted, thus cutting off the flow of high tension current.

In summary therefore, to operate either a magnetic type switch, or an electro-pneumatic contactor, to control the flow of high tension current, a low tension control circuit is necessary to operate the solenoid coil.

Control current (120 volt) is supplied by the supply motor generator or the nest of storage batteries.

To operate an electro-pneumatic contactor, in addition to control current, to operate the Solenoid, control air pressure is required to operate the contactor air piston.

The electro-pneumatic arrangement is often referred to as a magnet valve.

When the magnet valve is attached directly to the high tension contactor, this is termed a Unit Switch.

Since the unit switches are housed together in high tension compartments of the locomotive, they are referred to as Switch Groups.

The air cock termed the switch group isolating cock is located on the supply pipe between the pantograph and control reservoir and the switch groups, in the machinery compartment.

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ITEM 6.

EMPLOYMENT OF HIGH TENSION (1500 VOLT) CURRENT ON '46' CLASS LOCOMOTIVES.

When the 1500 volt current is available (via the pantographs) within an electric locomotive ten high tension machines are required to be driven by such in order that the locomotive may function in train haulage.

Six of these machines are called traction motors, four of these machines are called auxiliary machines and are named as follows:

The Supply Motor Generator.
The Exciter Motor Generator.
No. 1 Air Compressor Motor.
No. 2 Air Compressor Motor.

The six traction motors when driven by high tension current will each drive the locomotive axle to which it is connected and thus contribute to the tractive effort of the locomotive.

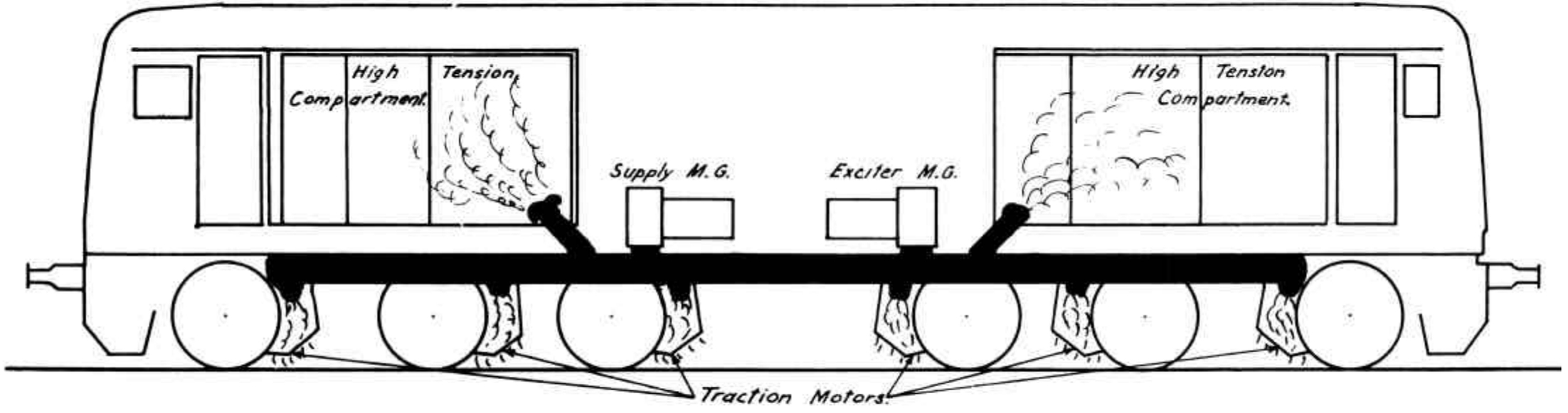
These traction motors are identified by being numbered. Running from the No. 1 end of the locomotive traction motor No. 1 leads, with motors Nos. 2 and 3 following on the No. 1 end bogie truck. No.4, 5, 6 motors follow in that order on the No. 2 end bogie truck.

The current being fed to Nos. 1, 2, 3 motors is read on the Ammeter, second from the right at the driver's station and the ammeter nearest the fireman-observer's station reads the current being fed to motors 4, 5, 6.

In train haulage the current readings on both ammeters should agree, (except where one bank of motors has been isolated).

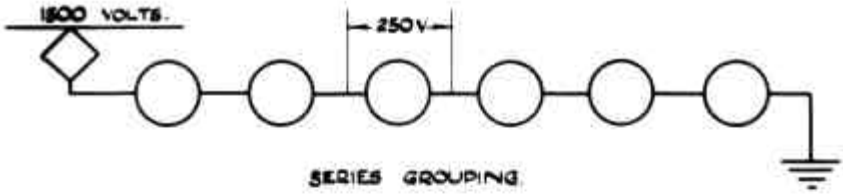
Any disagreement means that the armatures of certain motors are rotating faster than others and therefore wheel slip is occurring.

TRACTION MOTOR AND HIGH TENSION BLOWERS ARRANGEMENT.

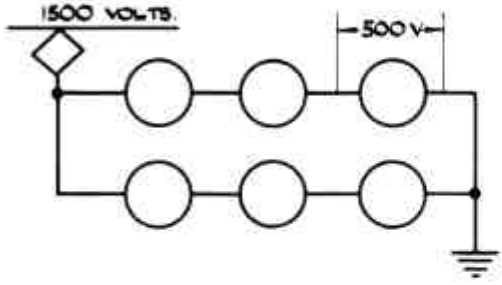


To ventilate and to prevent the intrusion of foreign matter to the Traction Motors and to the two High Tension compartments forced draught is applied.

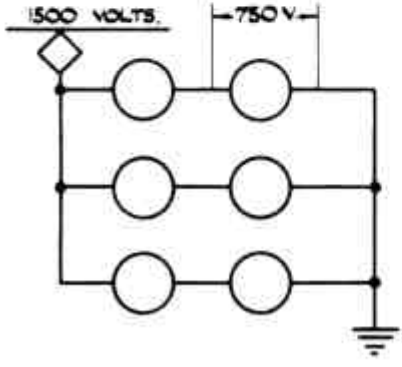
Attached to the Supply Motor Generator and also to the Exciter Motor Generator is a large centrifugal type fan blower. When these machines run a large volume of air is fed into a longitudinal duct. Proportions of this air are fed into each high tension compartment and to each of the Six Traction Motors.



SERIES GROUPING.



SERIES PARALLEL GROUPING.



PARALLEL GROUPING.

TRACTION MOTOR COMBINATIONS.

The use of the Regenerative Brake on 46 class locomotives employs the six traction motors to retard the locomotive and therefore the train. During this process however, the traction motors are acting as six generators.

The conversion of an electric motor into a generator is a simple matter requiring no alteration to the component parts, but merely some alteration to the current paths or circuits.

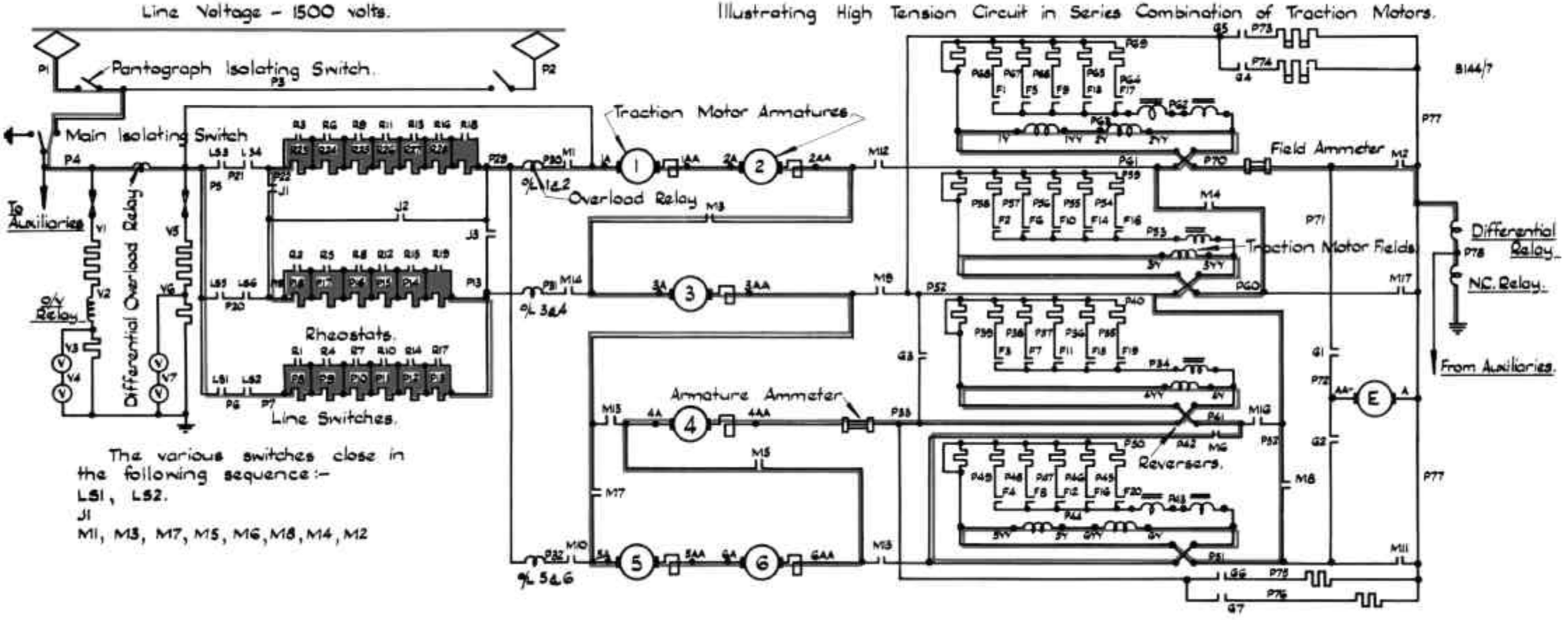
During this employment of the motors, the armature ammeter, that meter at extreme right at the driver's station, reads the amount of current now being regenerated by all six motors if the Series Combination is being used. If the Series-Parallel Combination is being used then two banks of motors are regenerating, and the armature ammeter current should be multiplied by two.

The current shown on the Field Ammeter, that meter second from the right reads the strength of the excitation current to the motor fields.

The Supply Motor Generator when driven by high tension current (at 1500 volts) produces-low tension current (at 120 volts) for purposes which will be described under instructions dealing with the control circuit.

The Exciter Motor Generator when driven by high tension current (1500 volts) also produces low tension current separate from the former machine output, and this current is used to drive the motors of eight resistances fans, and also to make it possible to convert the six traction motors into generators. Each of the two abovementioned machines also has attached to the armature spindle a large blower fan, so that when the machines run the two blowers run.

These blowers, called traction motor blowers, provide a large volume of air which is routed to the six traction motor, thus assisting in cooling them and also preventing any induction of metal filings, brake shoe dust, etc.


Line Voltage - 1500 volts.
Illustrating High Tension Circuit in Series Combination of Traction Motors.
Pantograph Isolating Switch.
Main Isolating Switch
To Auxiliaries
Differential Overload Relay
O/V Relay
Rheostats.
Line Switches.
Traction Motor Armatures
Overload Relay
Armature Ammeter
Field Ammeter
Traction Motor Fields
Reversers.
Differential Relay.
N.C. Relay.
From Auxiliaries.
The various switches close in the following sequence:-
LS1, LS2.
J1
M1, M3, M7, M5, M6, M8, M4, M2

When the motors of both No. 1 and No. 2 Air Compressors are driven by high tension current (1500 volts) air is induced, compressed, cooled and stored by the action of the respective compound compressors being so driven.

In summary the high tension circuit forks to two different paths, first the main high tension circuit which is directed through the traction motors, and secondly the auxiliary high tension circuit which junctions and branches away inside the locomotive, to drive the four auxiliary high tension machines. It is quite practicable to drive the four auxiliary machines whilst not using the other fork of the high tension current to the traction motors.

This condition is necessary to take care of the circumstances where the locomotive is standing or coasting.

However, the main high tension circuit cannot be used to drive the six traction motors unless the auxiliary high tension circuit is functioning, because this latter circuit provides a control system for controlling the former.

.....

ITEM 7.

THE CONTROL CIRCUIT.

The control circuit or low tension circuit on 46 class locomotives at 120 volts is supplied and maintained by the Supply Motor Generator.

A nest of storage batteries receives charging from the Supply Motor Generator.

For a very limited period only the charge held in the storage batteries will supply a control circuit and the only correct use of control current from this source of supply is in the initial stage of engine preparation and an emergency on the main line caused by failure of the supply motor generator, which cannot be corrected.

Current from the abovementioned sources is used by the driver to operate the pantographs, also a large group of contactors.

These contactors when operated either connect or disconnect the high tension current to the ten high tension machines of the locomotive and vary the path of such.

The storage batteries on 46 class locomotives have only limited storage capacity, therefore it is important to get the supply motor generator running early in the preparation routine and to keep it running during Traffic service.

When the supply motor generator is running and producing low tension current there is no demand on storage battery current also battery charging is taking place.

A continuous yellow lamp in the cab warns that the supply motor generator is not running.

If the supply motor generator 100 amp. fuse fails, there is no output from that machine even though it is running and battery current automatically takes over and supplies the control circuit. This condition is indicated by a "discharge" indication on the ammeter and the battery contactor will be open also the Exciter Motor Generator will stall.

LOW TENSION PANEL : NO. 2 END.

Additionally the cab heaters and food heaters will fail.

The included simplified Control Schematic diagram should be studied and referred to, as required, to explain the two sources of supply of control current and the reaction to either source failing.

The Battery Contactor is the connecting or dividing point of each source of supply.

This contactor is closed automatically if the supply generator is producing control current and opens automatically if no current is being supplied by the supply generator. A device located in the low tension cabinet controls the Battery contactor.

This device (not shown) is called the Reverse Current Relay, or Generator Automatic switch or Battery Relay.

If this device failed to open the Battery Contactor when no current was being produced by the supply generator, then the Battery current would flow back through the Battery contactor and drive the generator as a motor and discharge the batteries in the process.

.....

ITEM 7.

THE CONTROL CIRCUIT.
EXPLANATORY NOTES ON SCHEMATIC.

"A": The Supply Motor Generator which produces current at 120 volts and feeds it through
"B": Which is a 100 amp fuse on to the positive wire.

Control current is now routed through that group of miniature circuit breakers marked "C".

Control current output through "B" will operate a fitting (not shown) called the Battery Relay or Reverse current Relay, or Generator Automatic Switch.

This Battery relay will in turn close the Battery contactor marked "D" and supply current via "E" to the desk control key "F".

Control key "F" will now feed current to that group of miniature circuit breakers marked "G" and outside of the control key to that circuit breaker "H".

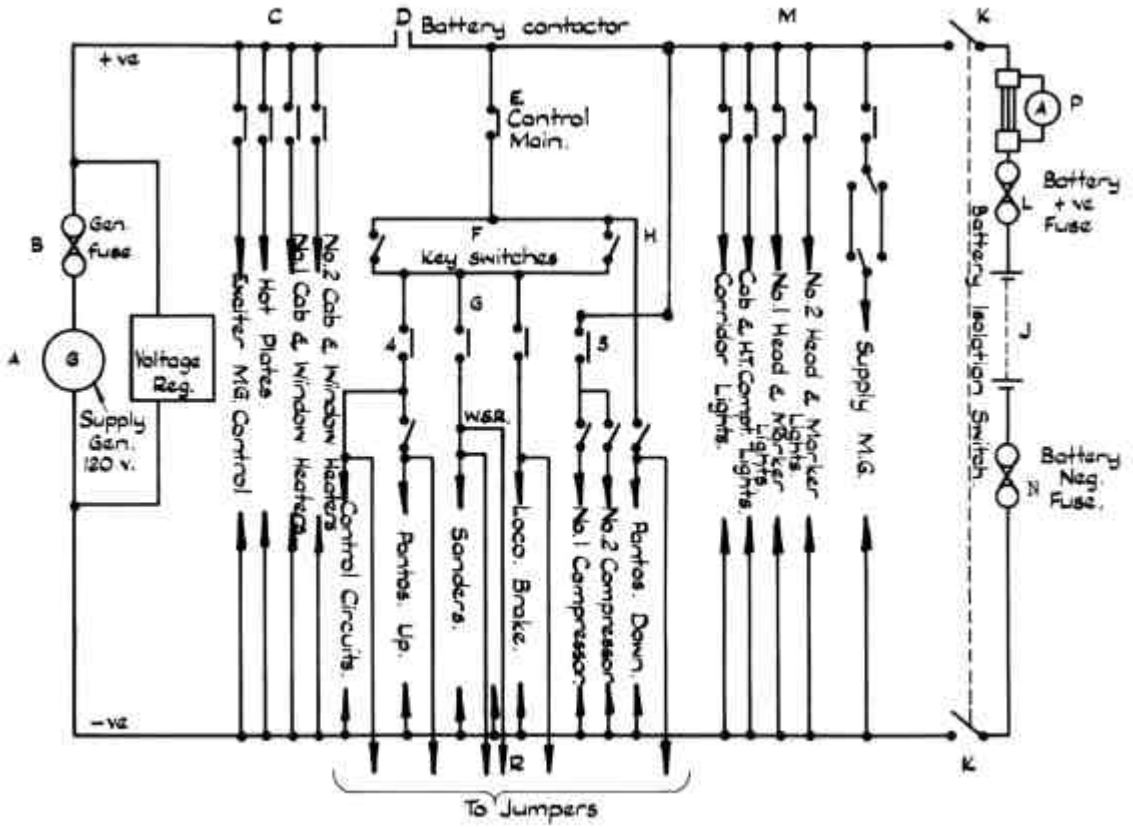
As well as feeding through "E" and connections the current is now available to that group of miniature circuit breakers marked "M".

With the Battery Double pole Switch "K" closed (connected) current feed is available via the 100 ampere fuses marked "L" and "N" to charge a nest of storage batteries marked "J".

The equipment marked "P" is the battery ammeter and this important device readily indicates if the batteries are being charged or discharged.

With no output from the supply motor generator "A" the battery contactor "D" will open and the batteries "J" will provide for a limited time control circuit as far as (but not through) battery contactor "D".

With this limited time battery circuit it will be seen on the simplified schematic all of the miniature circuit breakers marked "M" will be fed.



LOW TENSION CIRCUITS.

Unless the supply generator is producing current that group of miniature circuit breakers marked "C" cannot be fed.

With "E" closed and the supply generator "A" running, and producing current, and the batteries "J" connected through "K", group "E" and "H" are available. The control key must be in and on to feed that group of circuit breakers marked "G".

The extended control lines marked "R" are those which may be extended through the jumper couplers in M.U. working.

If the supply generator "A" or the 100 ampere fuse "B" should fail, the reverse current relay will open and disconnect the battery contactor "D".

The failure of fuses "L" or "N" would cause a failure of the battery circuit.

The failure of fuses "B", "L" or "N" would cause battery charging to cease.

The Battery charging ammeter in the low tension cabinet (No. 2 cab) should never show 'discharge', and the Battery contactor should be closed.

If the ammeter shows 'discharge' and/or the Battery contactor is not closed, inform the driver immediately. These indications show that Battery charging is not occurring and that the locomotive may be operated only for a limited period before total failure of the control circuit.

.....

Indication of depleted batteries on these locomotives is usually by the dimness of the cab lights and can often be detected during the preparation of the locomotive. If the cab lights are not bright before the supply generator starts and the initial charging rate is about 30 amperes this will indicate low batteries.

If the batteries are high the charging should be between 2 and 10 amps.

Where cab lights are observed as being unduly dim when fed from the batteries alone and with the supply motor generator now started up only a low charging rate is indicated on the battery ammeter the condition of the battery is suspect and under these circumstances do not switch off the supply generator before arrival at destination.

The battery ammeter is under all circumstances the best indication of the condition of the batteries and in some cases of very low batteries it is possible for a charge of 50 amps to be indicated, but this charge should not be maintained for more than 10 minutes and in this period should fall to approximately 10 amps. Should the charge rate be maintained at 50 amps for over 10 minutes the battery double pole switch should be opened and the batteries taken out of the charging circuit.

If an inspection of the battery contactor is made at any time do not lift the arc chute covering the contactor whilst the generator is running.

During the course of the preparation make an inspection of the battery ammeter with the generators running and compare the charge rate with the conditions given previously. Before switching off a supply generator make another inspection and do not run the locomotive with the generator switched off. Remember that if the batteries are depleted badly and the generator switched off the locomotive will be a failure.

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ITEM 8.

PANTOGRAPHS AND PANTOGRAPH CONTROL.

The Pantograph provides the means of connecting the overhead line voltage or disconnecting it from the locomotive.

Raising or lowering of pantographs must never be done whilst any current is being drawn.

Current is being drawn when either the throttle is open or any of the four auxiliary high tension machines are running.

During light engine running the rear pantograph only is to be employed.

During all train working both pantographs are to be employed.

If only one pantograph is employed in train working all of the machines may be adequately fed, but severe sparking would take place if the current draw was heavy.

However, between Westmead and points East thereof where two or more locomotives are attached, only one pantograph is to be employed on each locomotive.

This exception is due to the lighter nature of the overhead wire.

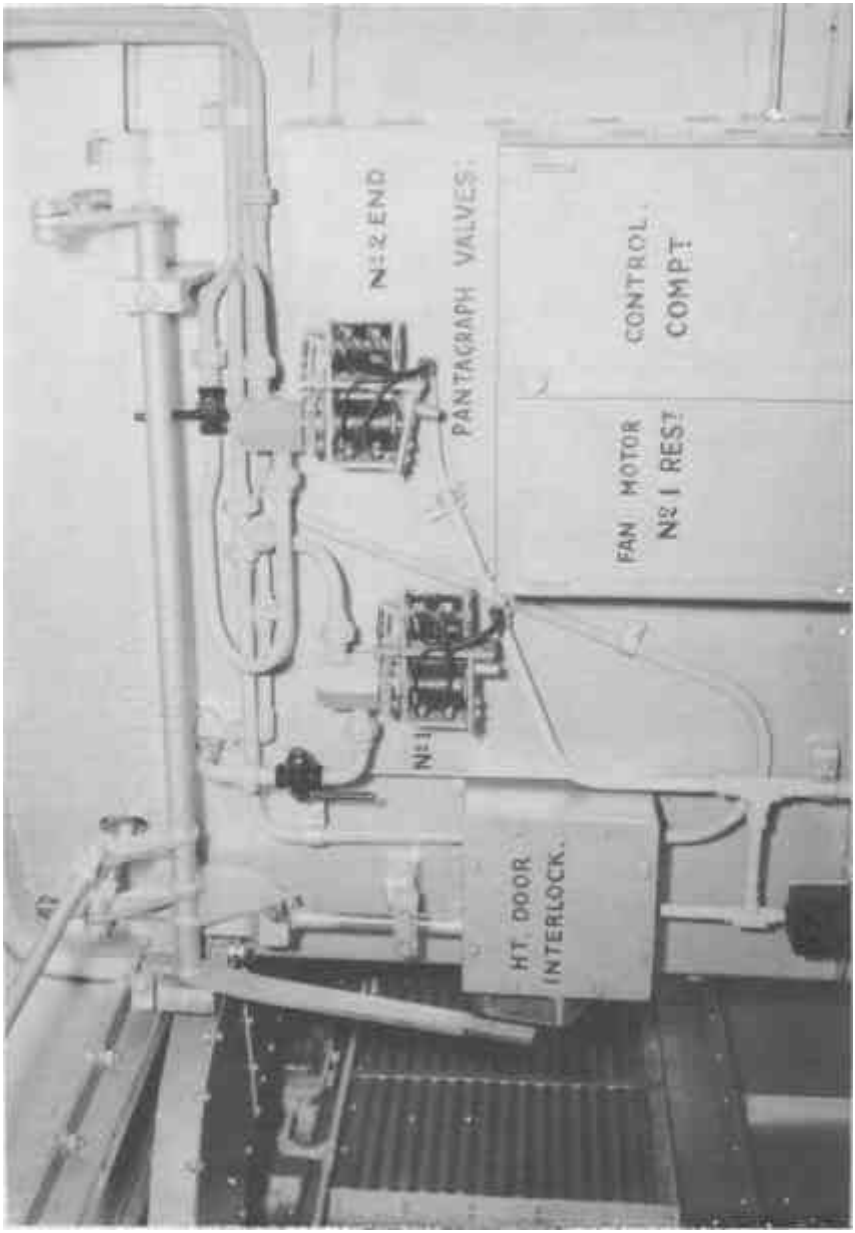
A yellow symbol with a black centre means stop and ascertain that the route intended is wired.

A Red Stop Board means stop and lower and isolate all pantographs if the 46 class locomotive is required to be hauled beyond that point.

Failure to observe these simple rules will cause serious damage to the pantographs.

Pantograph Raising and lowering reactions are to be visually inspected by the fireman-observer, with report to the driver.

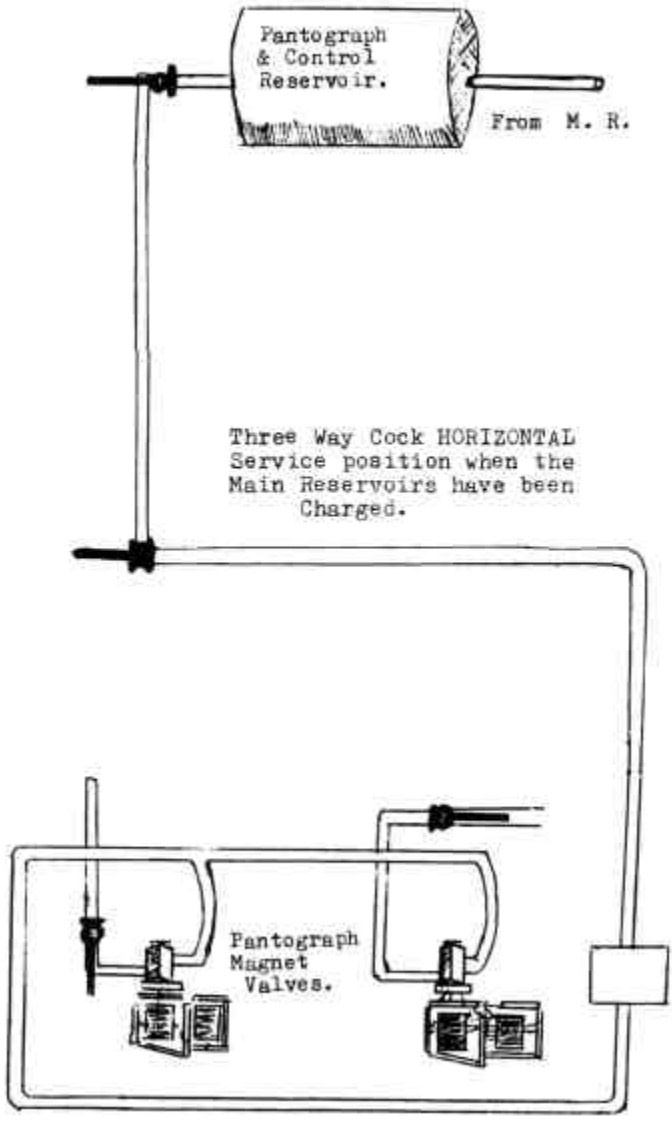
Before entering a high tension compartment as well as operating the lowering and isolating pantograph mechanism, it is essential to observe that the panto-graphs have folded down. It is quite possible for the pantograph to remain in contact with the overhead wire after lowering magnet valves have been operated, due to stiffness of the pantograph details.



PANTOGRAPH RAISING AND LOWERING MAGNET VALVES.

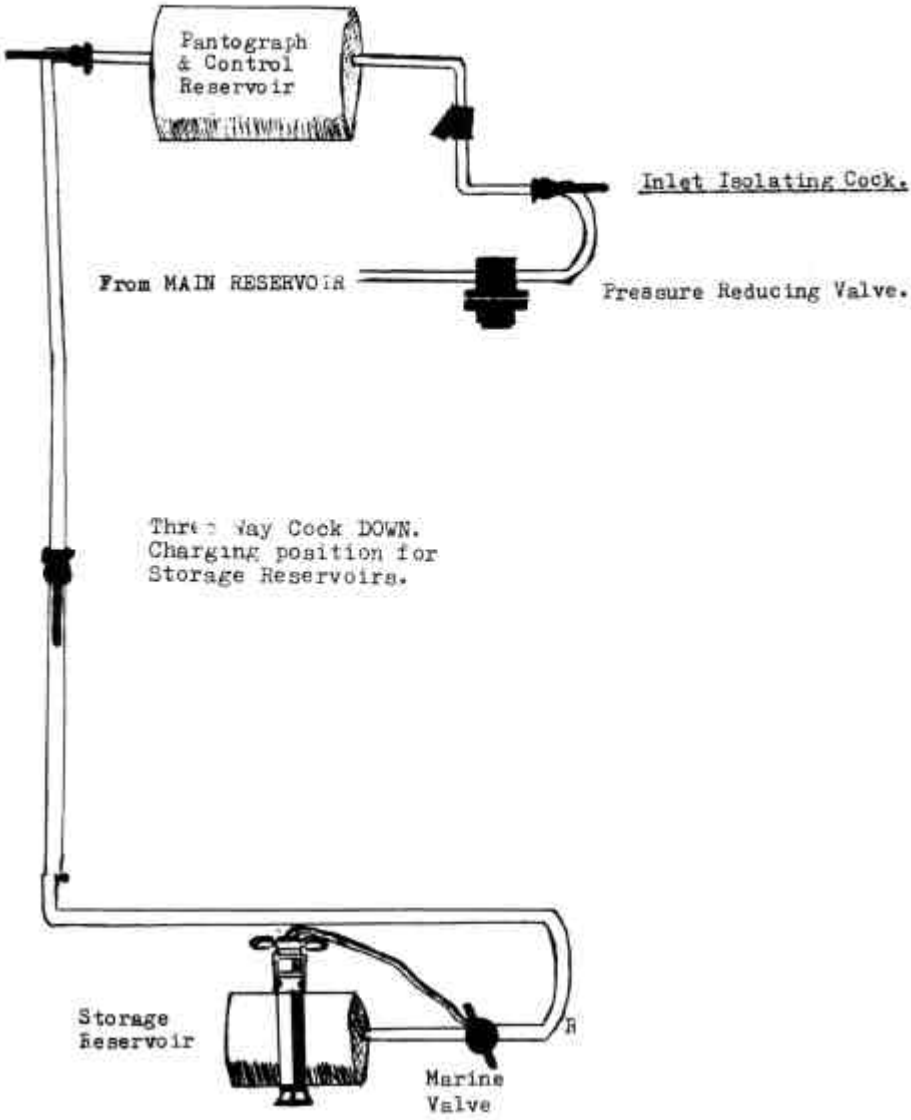
PANTOGRAPH (AIR) CONTROL.

ILLUSTRATING THE THREE WAY COCK.



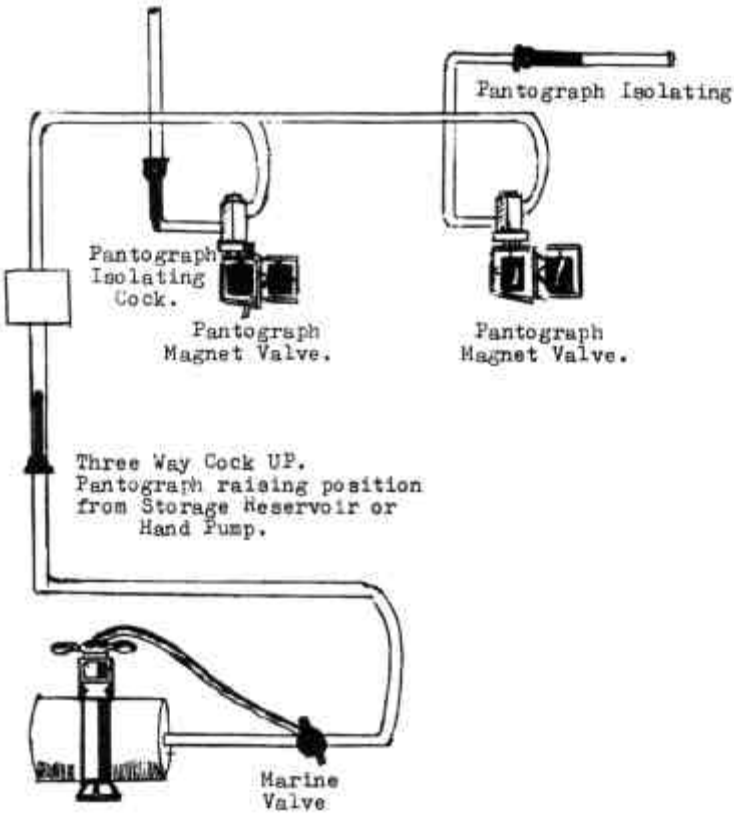
PANTOGRAPH (AIR) CONTROL.

ILLUSTRATING THE THREE WAY COCK.



PANTOGRAPH (AIR) CONTROL.

ILLUSTRATING THE THREE WAY COCK.



To provide two seperate sources of air for pantograph raising air from pantograph and control reservoir is routed to storage reservoir and trapped at marine valve and later also trapped in pantograph and control reservoir by closing inlet and outlet isolating cocks.

To raise a pantograph it is necessary to have a supply of compressed air and to route it to the pantograph cylinder on the roof.

To lower a pantograph it is necessary to prevent air flow to the roof cylinder and to discharge that air already present.

These actions may be made by hand manipulation of the armature plate of the pantograph magnet valve, and this method may be used when a fault exists in the raising or lowering buttons on the cab desk panel.

To raise pantographs by remote (cab desk buttons) control it is necessary that the control current is present through the control key, via the Battery switch.

To lower pantographs by remote (cab desk buttons) control it is not necessary to have the control key switched on, but Battery current must be switched on.

.....

ITEM 8.

PANTOGRAPHS AND PANTOGRAPH CONTROL.

There are two pantograph magnet valves.

Each magnet valve refers to the raising and lowering of one pantograph. (No. 1 end pantograph and No. 2 end pantograph).

Each magnet valve, conforming to that description contained in item 5, has two solenoid coils inbuilt.

When the desk raising button switch is pressed, control current will flow to the raising solenoid. This solenoid now being a temporary magnet will attract the vertical armature plate, which will then allow the horizontal armature plate to fall down.

When this latter armature plate falls down, it permits an air valve to open and route pantograph and control reservoir air pressure to the pantograph roof cylinder.

The piston of the pantograph roof cylinder now forced out to full stroke releases a pawl which permits two raising springs to exert their force on the pantograph, unfolding it and forcing it into contact with the overhead high tension wire with a spring pressure of about 28 P.S.I.

When the desk lowering button switch is pressed, the raising solenoid is de-energised and the lowering solenoid is energised.

The vertical raising armature is released the horizontal lowering armature plate is attracted.

When the lowering armature plate is thus retracted, it engages the air valve, cuts off pantograph and control reservoir air flow and discharges the air from the pantograph roof cylinder.

The pantograph lowering springs now take charge and cause the pantograph to break away from the high tension overhead wire and fold down.

It is necessary to have control current through the desk control key for pantograph raising from the desk buttons.

The pantograph three-way control air cock must be placed horizontal to route air from the pantograph and control reservoir to the pantograph roof cylinder, and it must be placed vertically upwards to route air from the storage reservoir or emergency hand pump.

In both cases, also the pantograph isolating cocks should be open.

These are located immediately above the magnet valves.

If the desk button switches fail to energise either the raising or lowering solenoids of the magnet valves, the armature plates may be hand operated.

Unless the high tension main switch is closed and locked with the Reverser Key, air cannot be routed to the pantograph roof cylinder, and any air contained in the roof cylinder is vented when the main high tension switch is unlocked.

In multiple unit working, the control current which operates the pantographs on the front locomotive, also feeds through the jumper coupler to cause similar actions on the rear locomotive.

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ITEM 9.

AIR HOSES ON 46 CLASS LOCOMOTIVES, THEIR EMPLOYMENT AND SPARE HOSE EQUIPMENT TO BE CARRIED. THE LOCATIONS OF AIR HOSES IN USE.

On the Driver's side of the locomotive at each end a 1" head brake pipe end type air hose and dummy coupling.

On the Fireman's side at each end a 3/4" head main reservoir and air hose and dummy coupler - Note - these two (2) air hoses are not interchangeable.

On the Driver's side each end connecting between car body and bogie frame, one sand circuit intermediate type air hose and one brake pipe intermediate air hose.

On the Fireman's side each end connecting between car body and bogie frame, one main reservoir, one brake cylinder, and one sand gear intermediate type air hose.

These intermediate type air hoses are referred to as flexible air hoses as they connect the two mobile portions, the car body and the bogie frames.

Two flexible air hoses on the roof of the 46 class locomotives convey air for the operation of the pantograph pistons.

Two 1/2" type 'B' air hoses which are used in Multiple Unit working to connect across the No. 3 and No. 4 Independent brake pipes are carried when not in use, in the corridor of No. 2 End of the Locomotive.

Spare hoses carried in the equipment box for wayside replacement purposes are:-

One main reservoir end type air hose.
One brake pipe end type air hose.
One flexible intermediate type main reservoir air hose.
One flexible intermediate type brake cylinder air hose.
One intermediate type sand circuit air hose.

It should be always remembered that spare main reservoir and brake pipe air hoses are conveniently located on the unconnected end of the locomotive.

No spare replacement flexible hoses for the pantographs are carried.

NOTES OF REPLACEMENT.

The two flexible air hoses on the roof may be separately isolated, should they burst by closing the applicable isolating cock in the machinery compartment. The air pressure in the Pantograph and Control reservoir will readily indicate the isolating of the defective hose.

It should not be overlooked that if the Pantograph and Control Reservoir is greatly in excess of 70 P.S.I., this excess pressure may be the cause of the burst hose. Should excess pressure be the cause of the burst hose, adjust the pressure in the pantograph and control reservoir to 70 P.S.I. at the pressure reducing valve.

During train working if the flow meter indicates a burst air hose:-

(a) First ascertain if the two intermediate and one end brake pipe hoses on the locomotive are not involved.
(b) carry the correct spare hose and tool along the train until the burst hose is located.
(d) where any interference with the brake pipe is necessary take special care that both relevant end air cocks have been fully opened.

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ITEM 10.

AUTOMATIC ALARMS AND SAFEGUARDS.

Under this heading there are four devices on the '46' class locomotive.

These are:

(a) The Line Switch Indicator Lamp.

(b) The Motor Generators and Resistance Fans Lamp.

(c) The Wheel Slip Relay Buzzer and Lamp.

(d) The Westinghouse Brake Flow Meter and Indicator.

(a) The line switch lamp is the red lamp and it will flicker momentarily, as a normal function, when the throttle is moved from "off" to notch one, if the line switches close and connect high tension current feed to the traction motors.

Where due to a fault, one bank of motors has been isolated, the line switch lamps will no longer be in circuit.

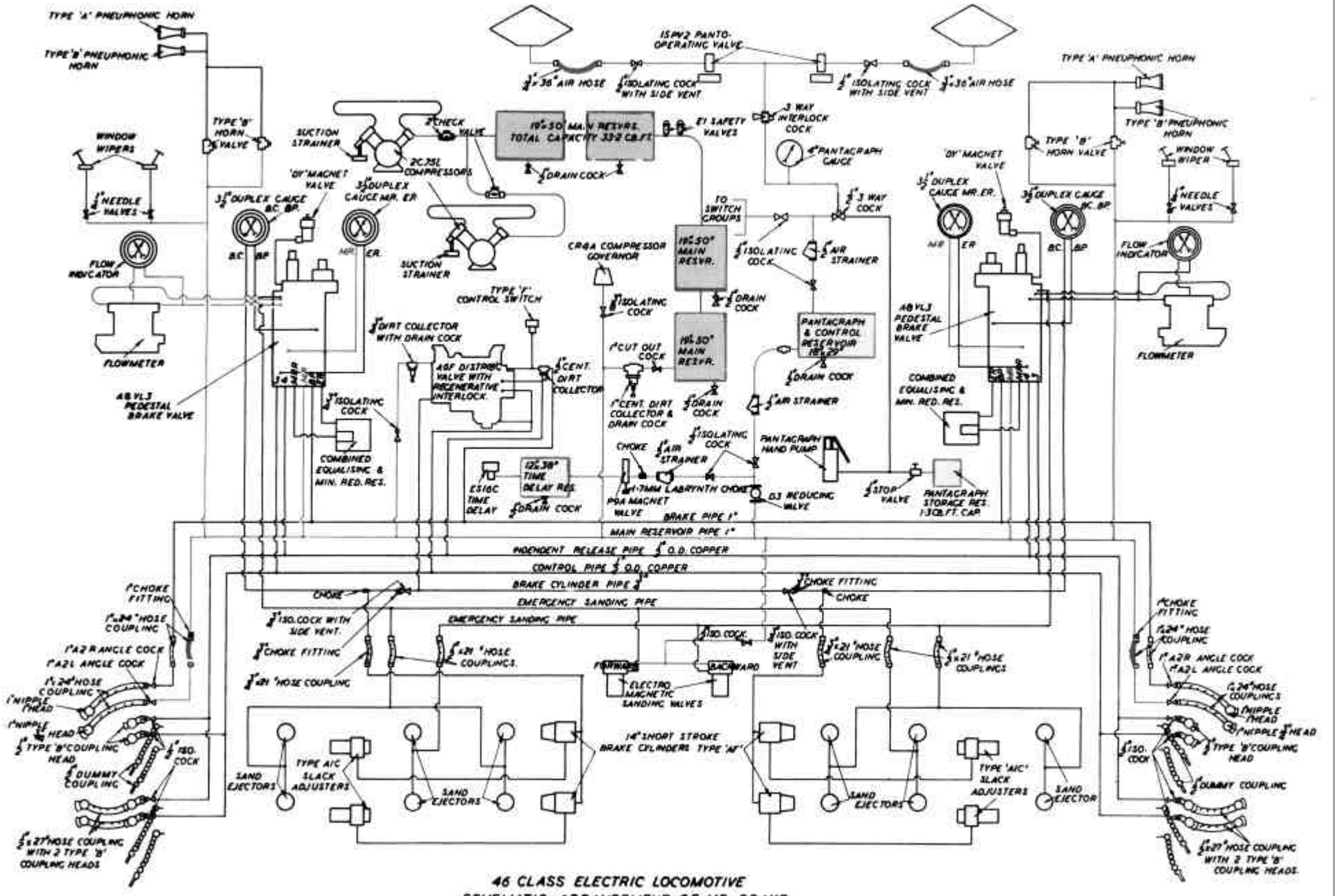
If, whilst the throttle is open, any fault develops in the high tension circuit, one of four protective relays will intervene and automatically open the line switches, on fault, (thus cutting off current flow to the traction motors).

The red lamp will shine continuously to warn the driver of the occurrence.

Since the line switches are of the electro-pneumatic type, a failure of the control current circuit, or the control air pressure, would cause these to open on fault.

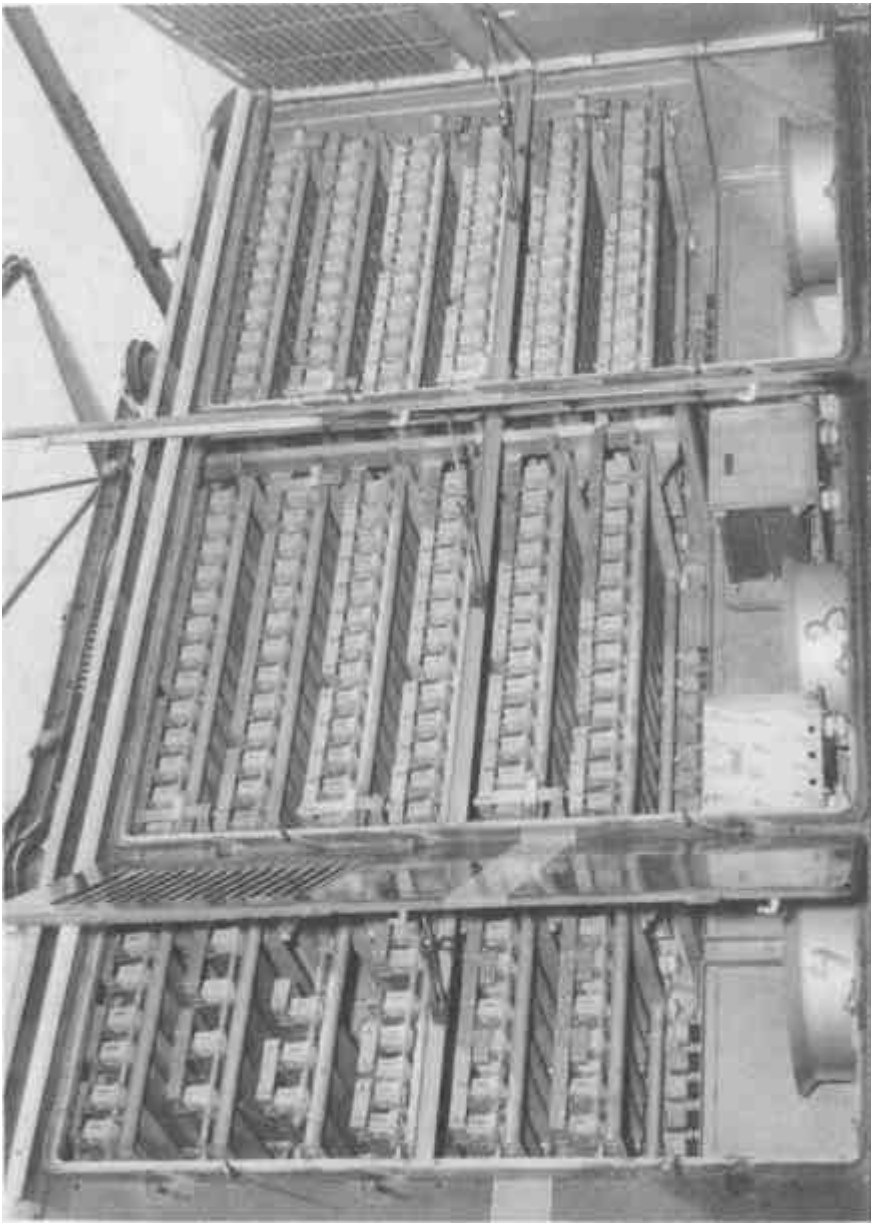
Again the red lamp would shine in warning.

When the Regenerative Brake lever is moved to the braking field, the red lamp will shine, as an ordinary event, until the throttle is opened.

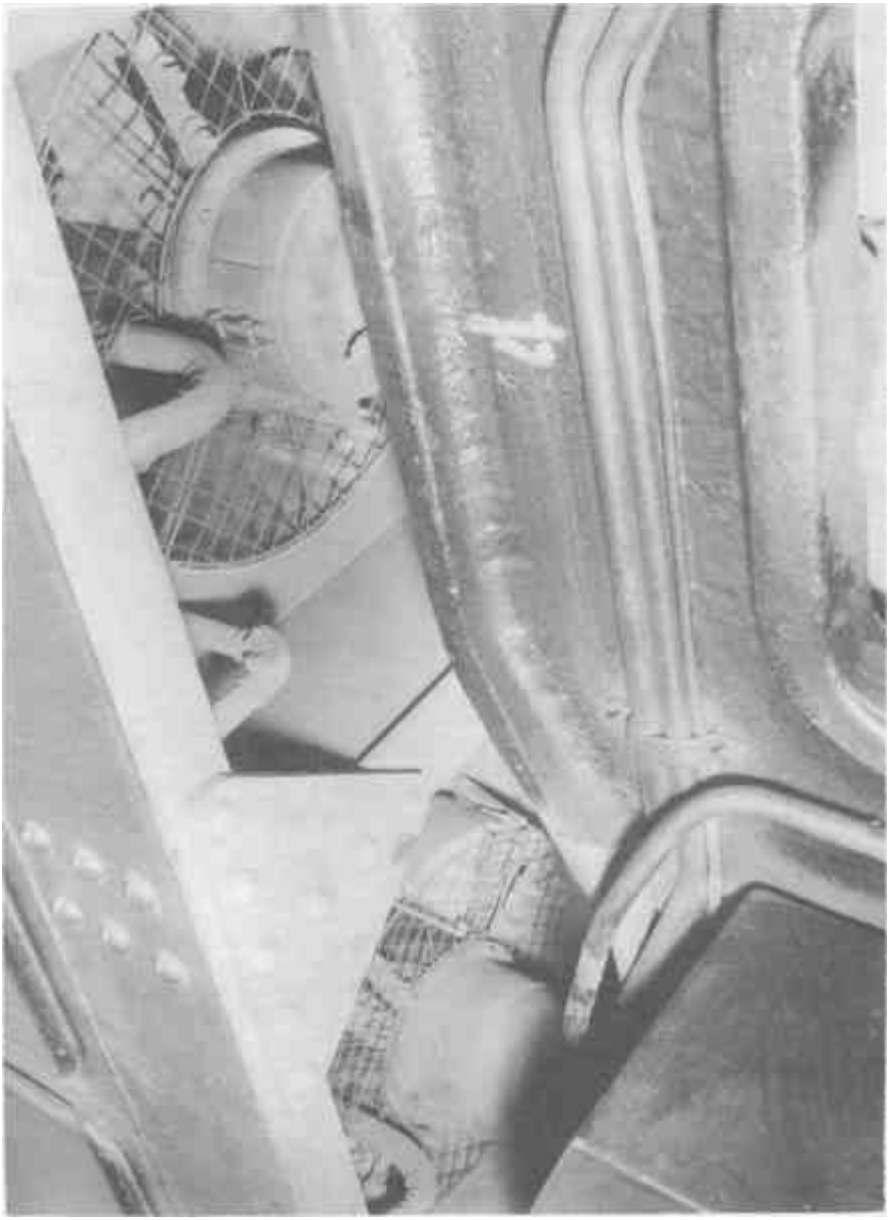


46 CLASS ELECTRIC LOCOMOTIVE
SCHEMATIC ARRANGEMENT OF AIR BRAKE, AUXILIARY EQUIPMENT & PIPING

FIG. 23. AIR BRAKE PIPING.

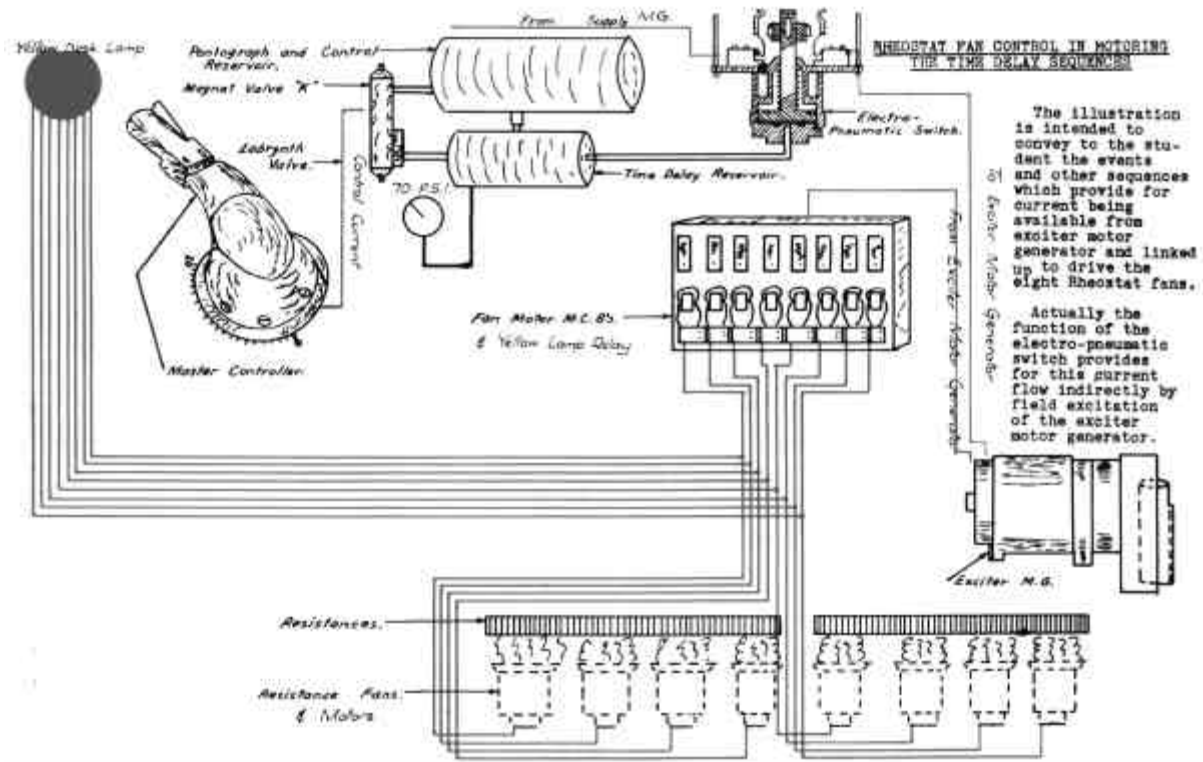


MAIN STARTING RESISTANCES.



RESISTANCE FAN MOTORS.

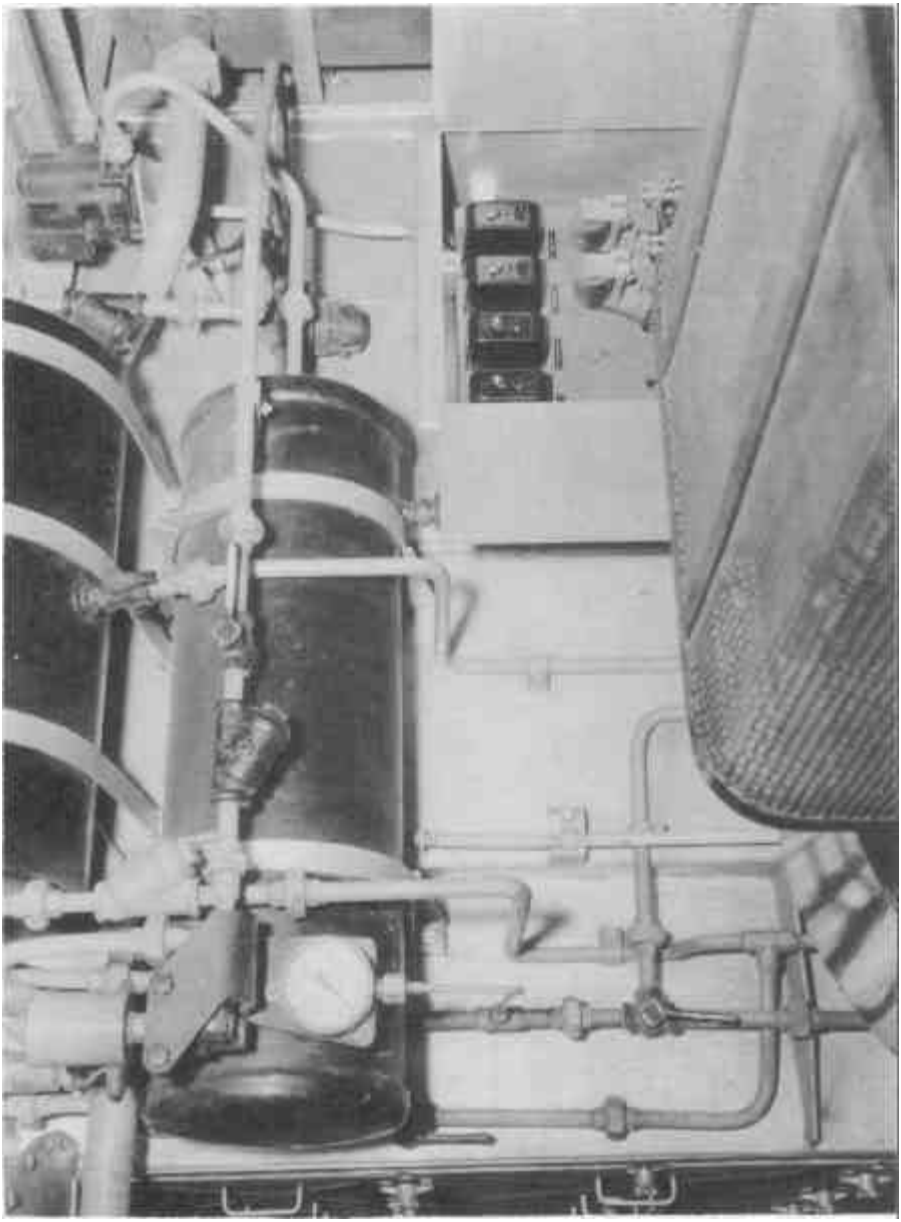
RESISTANCE FAN MOTOR CIRCUITS.



RHEOSTAT FAN CONTROL IN MOTORING TIME TIME DELAY SEQUENCES

The illustration is intended to convey to the student the events and other sequences which provide for current being available from exciter motor generator and linked up to drive the eight Rheostat fans.

Actually the function of the electro-pneumatic switch provides for this current flow indirectly by field excitation of the exciter motor generator.



RESISTANCE FAN MOTOR MINIATURE CIRCUIT BREAKERS AND FAN TIME DELAY RESERVOIR.

(b) The Motor Generators and Resistance Fans lamp is the yellow lamp.

At all times when control current is available through the Desk Control Key, if the supply motor generator is not running, the yellow lamp will shine continuously to warn the crew that neither the supply motor generator, nor the exciter motor generator is running, and therefore, battery charging is not taking place, that the battery charge is being bled away and that traction motor blowing is not taking place.

When the throttle is opened and until it is positioned at notch twenty (20), the high tension current flowing to the traction motors is being routed through all, or some, of the nineteen main starting resistances in order to graduate the starting effort.

These resistance units are housed in each high tension compartment immediately behind the fireman-observer's station.

These resistance units produce heat which after one minute require forced ventilation.

Below each Resistance Compartment, four powerful resistance (or Rheostat) fans are located.

Each has its own inbuilt motor.

One minute after the high tension current is feeding through the resistances, these eight fan motors should start the fans running to ventilate the resistances.

If all, or any, of these fans fail to run and the throttle has not reached notch 20, the yellow lamp will shine to warn the crew.

The principal causes of resistance fans failure are:

Supply motor generator, (and exciter motor generator) not running.

Resistance fan Thermal Circuit Breakers tripped.

A simple and effective test for the resistance fans is to start up the supply motor generator, turn off and then turn on the desk control key, and then place the throttle in any resistance notch (1-19).

After one minute the yellow lamp will go out if all resistance fans have started up.

Some of the causes of Rheostat fan failures are:

(1) Supply Motor Generator not running.

Supply Generator is running, but the 100 amp. fuse is burnt out.

The exciter motor generator supplies the current which drives the fan motors, but the exciter motor generator will not run unless the supply motor generator is running and producing current through the 100 amp. fuse.

An electro-pneumatic switch housed in the machinery compartment is used to connect current, or disconnect it from the eight Rheostat fan motors.

A pressure of air at 60 P.S.I. is required to close (connect) this switch.

The 60 P.S.I. air pressure is fed into the Time Delay Reservoir for this purpose from the Pantographs and Control Reservoir. So that if the P. and C. Reservoir is isolated, or does not contain sufficient pressure, or the Time Delay Reservoir is isolated, then the electro-pneumatic switch would not connect up the Rheostat fan current.

Housed in two separate cabinets in the machinery compartment, are a total of eight thermal type circuit breakers.

The current to drive the eight Rheostat fan motors feeds in parallel through these.

If any one, or all, circuit breakers trip under current load that, or those, Rheostat fans will stall and the yellow lamp will shine.

(c) The wheel slip relay equipped to 46 class locomotives is for the purpose of warning the driver of the slip (in motoring) or slide (in Regenerative Braking) of any of the locomotive wheels.

When wheel adhesion to the rail is correct, a similar volume of current is fed to each traction motor (which is pinioned to the related locomotive axle); when any wheel slips the armature of the traction motor has to rotate faster and there is a differential of current feed, therefore, between the gripping and the slipping wheels.

This condition brings the wheel slip relay to life and this relay feeds control current to operate the wheel slip buzzer and pilot lamp. The control current to operate the buzzer and lamp is routed through the Locomotive Sand miniature circuit breaker (No. 5).

Experimentally another relay has been equipped to engine 4625, which comes to life at any time the master controller accelerating handle is positioned at notch one, and again control current will feed the wheel slip buzzer and pilot lamp.

This arrangement is intended as a warning that current is being fed through the resistances and with such insistence that a driver cannot erroneously return the throttle to notch one, when intending to shut off.

(d) The Westinghouse Air Brake Flow Meter and Indicator.

This device has the important function of warning the crew that the brake pipe pressure has been interfered with outside of the operation of the driver.

In other descriptive words, therefore, the flow indicator will warn if the Guard or Passenger Emergency air cocks are opened, if an brake pipe air hose, or any connection is leaking or is burst, and if the train has become divided.

The Flow Indicator will function only if the driver's Automatic Brake Valve handle is in Running Position and the Brake Valve isolating cock open.

The warning of any irregularity in Brake Pipe pressure within the abovementioned conditions, will be made by an insistent blow of warning air at the flow meter vent port and the two pointers of the Flow Indicator will widely separate and remain at that indication until the brake pipe pressure has been restored.

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